QUALITY OF THE DRINKING WATER OBTAINED IN ILLINOIS BY COMMON CARRIERS

BY

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THESIS

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY WESLEY WALLACE HANFORD

ENTITLED QUALITY OF THE DRINKING WATER OBTAINED IN ILLINOIS BY COMMON CARRIERS.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science

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INTRODUCTION

The difficulties encountered in providing an army on the move with proper food and pure and wholesome water is repeatedly mentioned in the newspapers. Every great railway system in this country has every day such a problem on its hands, and to furnish the army of travelers with uncontaminated water in its dining cars and railway trains is a task of no mean proportion.

Just recently, health officers and the public have had their attention directed to the quality of the water served on railway trains and in other public vehicles, including the method of dispensing the water. The bacteria found on public drinking cups have been of such a character as to condemn the public cup as being a menace to public health. Even tho the public cup is abolished there yet remains the problem of protecting the purity of the water ordinarily served on railway trains and in the railway stations. The Treasury Department has jurisdiction over the health of passengers in interstate traffic and has passed laws on the subject.

In all, to date, there have been nine amendments to the Interstate Quarantine Regulations promulgated by the Treasury Department, September 27, 1894, said amendments and regulations being in accordance with Section 3, General Regulations, Act of Congress, approved February 15, 1893. The first three amendments do not concern water; the fourth takes up common drinking cups; the fifth, common towels; the sixth to ninth, inclusive, are concerned with water.

Article 3, General Regulations, is amended by the addition of the following paragraphs:

Pure Drinking Water for Passengers in Interstate Traffic.

"Paragraph 15.--Water provided by common carriers on cars, vessels, or vehicles operated in interstate traffic for the use of passengers shall be furnished under the following conditions:

(a) Water shall be certified by the State or municipal health authority within whose jurisdiction it is obtained as incapable of conveying disease: Provided, That water in regard to the safety of which a reasonable doubt exists may be used if the same has been treated in such manner as to render it incapable of conveying disease, and the fact of such treatment is certified by the aforesaid health officer.

(b) Ice used for cooling such water shall be from a source the safety of which is certified by the State or municipal health authority within whose jurisdiction it is obtained, and before the ice is placed in the water it shall be first carefully washed with water of known safety, and handled in such manner as to prevent its becoming contaminated by the organisms of infectious or contagious disease: Provided, That the foregoing shall not apply to ice which does not come in contact with the water which is to be cooled.

(c) Water containers shall be cleansed and thoroly scalded with live steam at least once in each week that they are in operation."

Franklin Mac Veagh, Secretary."

January 25, 1913.

Water for Drinking and Cooking Purposes Furnished Interstate Vessels. (Amendment to Interstate Quarantine Regulations. No. 7.)

"Paragraph 16.--No person undertaking to furnish water for drinking or cooking purposes to any vessel in any harbor of the United States, intending to clear for some port within some other State or Territory of the United States or the District of Columbia, shall furnish for such purposes water taken from the waters of such harbor or from any other place where it has been or may have been contaminated by sewer discharges. Any person violating this regulation will be liable to a penalty of not more than $500 or imprisonment for not more than one year, or both, at the discretion of the United States district court.

W. G. McAdoo, Secretary."

June 4, 1914.

Pure Drinking Water for Crews and Employees of Common Carriers Engaged in Interstate Traffic. (Amendment to Interstate Quarantine Regulations No. 8.)

"Paragraph 17.--Common carriers while engaging in interstate traffic shall not furnish to their crews or employees any polluted water for drinking purposes which may contain organisms or materials likely to cause a contagious or infectious disease, nor shall such carriers maintain or permit to be maintained upon their vessels or vehicles, or at or near their stations or other ordinary stopping places over which they may have control, any tank, cistern, receptacle, hydrant, or article with water which may contain such impurities, in such manner that water therefrom may be conveniently obtained by the crews and employees mentioned for drinking purposes, unless such common carriers maintain a notice upon said vessels or vehicles and at, near, or upon every said tank, cistern, receptacle, hydrant, pump, well, stream, brook, pool, ditch, or other place or article, with water therein containing such impurities, forbidding the use of such water for drinking purposes by the crews or employees of the said common carriers or by the general public while engaging in interstate commerce.

W. G. McAdoo, Secretary.

September 16, 1914.

Pure Water for Passengers upon Vessels Operating in Interstate Commerce. (Amendment to Interstate Quarantine Regulations No. 9.)

"Paragraph 18.--Common carriers operating vessels in commerce between the several States and Territories or the District of Columbia, for passengers in interstate traffic, shall not supply for the use of said passengers any water taken from a lake or stream over which the vessel is being navigated unless the same is certified by the United States Public Health Service or the State or municipal health authority within whose jurisdiction it is obtained as conforming to the bacteriological standard for drinking water promulgated by the Secretary of the Treasury under date of October 21, 1914: Provided, That water in regard to the safety of which a reasonable doubt exists may be used if the same has been treated in such manner as to render it incapable of conveying disease, and the fact of such treatment is certified by the aforesaid health authority or by the Surgeon General of the United States Public Health Service or his accredited representative.

W. G. McAdoo, Secretary."

January 12, 1915.

In order to enforce the regulations a commission was appointed to formulate standards. This commission was composed of the following members:

John F. Anderson	Edwin O. Jordan
Edward Bartow	Allan J. McLaughlin
Charles C. Bass	William H. Park
S. J. Crumbine	Milton J. Rosenau
Edward C. Franklin	William T. Sedgwick
Henry Hanson	George C. Whipple
Charles Gilman Hyde	C.-E. A. Winslow

Wade H. Frost

According to the report of the commission, they recognized that the difficulties in the way of establishing definite standards of purity for water are many. Quoting from the report: "It is recognized, however, that the standards are to a certain extent, arbitrary, being necessarily based upon opinion rather than definite evidence. They must, therefore, be subject to the criticism applicable to all expressions of personal opinion not susceptible to definite proof."

It is impractical to require pure water. Pure water is something of a curiosity. The puriest on record, K (specific conductance) = $.0404 \times 10^{-6}$, at 18° was obtained by Friedrich Kohlrausch,* after spending ten years in cleaning the glass receiver of the distilling apparatus. There is an unbroken grada-

*Zeit. Jur. Phys. Chem. 14, 317-330.

tion from this absolutely pure water to that which has an excessive mineral content or is grossly polluted by organic impurities.

There are various opinions concerning the effect of the impurities of water on the human body.

Rosenau* maintains that as a rule water is not to be

*Preventive Medicine and Hygiene, by Milton J. Rosenau.

considered a food, for it may be said to have little or no value when estimated as a force producer within the body. Much of the water which is either drunk or ingested as a part of other foods passes thru the body unchanged, but some of it enters chemically into other compounds. The nature of these processes is obscure, and as yet very little understood.

Water is entitled to rank as a food because it enters into the structural composition of all foods as well as all the tissues of the body; it is one essential element of diet, even tho it cannot of itself build tissue, repair waste, or produce heat or energy. "The cells of the body are aquatic in their habits."

The use of water in the body may be summarized as follows: "It forms the chief ingredient of all the fluids of the body and maintains their proper degree of dilution, and thus favors metabolism; by moistening various surfaces of the body, such as mucous and serous membranes, it prevents frictions; it furnishes in the blood and lymph a fluid medium by which food may be taken to remote parts of the body and the waste material removed, thus promoting rapid tissue changes; it serves as a distributor of body heat; it regulates the body temperature by the physical process of absorption and evaporation."

There are disorders other than specific gastrointestinal infections caused by impure water. Due to their obscurity, these are very often overlooked. Rosenau states that it is not always plain just what quality or what impurity in the water is responsible for these nonspecific disorders, and the diseases themselves may present a vague and ill-defined clinical picture. The relationship has been worked out in only a few instances.

A turbid or malodorous water may not in itself be particularly injurious to health, but, on account of its unattractive appearance or repulsive condition, less may be taken than is necessary for the maintenance of good health. In this way water may be indirectly responsible for much harm.

It was thot until recently that the formation of concretions such as urinary and biliary calculi was dependent upon the inorganic salts in water. Later it has been shown that biliary calculi usually form about a colon bacillus or a typhoid bacillus or about some pathological particle as a nucleus, and that urinary calculi probably have a similar pathogenesis. There is no known relation between these concretions in the body and the inorganic salts in water, even those in a very hard water.

Goiter is a disease supposed to be caused by some poison or infection taken into the system with the water or with some other article of diet.

Bircher* has shown that goiter occurs essentially

*Med. Klinik, 1908, Heft, 6.

among those living upon marine deposits or paleozoic, triassic, and tertiary periods, whereas volcanic formations, crystalline rock of archaic age, stratified deposits of the Jura and Kriedemeer, and all fresh water deposits are free.

Wilms* assumes that the cause of goiter is not a living

*Deutsche med. Wochenschr. March 31, 1910, pp. 604.

organism, but that it is due to unknown substances derived from the bodies of marine animals.

Lobenhoffer* studied the presence of goiter in the

*Lobenhoffer, W. :"Die Verbreitung des Kropfes in Unterfrauken"
Mitterlung aus den Grenzgebieten der Med. und Chir.
Jema XXIV, No. 3, pp. 383-606.

Unterfrauken district. Boiling the water seems to do away with its goiter-producing properties.

According to Ossler, Dock, and Adams, the region of our Great Lakes shows considerable numbers, but in United States and Canada the goiters are not large and cretinism is rare.

Lead is practically never found in natural waters. The source of the lead in the water is almost always lead service pipes, or some other lead object used in collecting, storing, or delivering the water. Lead is the most dangerous inorganic substance with which our drinking water is ordinarily contaminated. Lead poisoning from lead in drinking water is much more common than it is given credit for. All natural waters have some solvent action. The only sure method of determining to what degree a given water will take up lead is by testing the question experimentally under practical conditions and determining the amount of lead taken up.

M. Neisser* reports a number of cases of lead poisoning due to the use of lead pipes. The quantity of lead varied between 0.7 and 12.5 mg. per liter.

*Gesundh. Ing., 36, 920-2.

A Schwenkenbecher* reports cases of lead poisoning due to water conducted by lead pipes.

*Münch. med. Wochschr., 61, 352.

H. Klut* mentions a large number of authentic lead poisoning cases due to water and suggests as a limit .3 milligrams of lead per liter.

*Med. Klinik, No. 13. (1914)
Wasser und Abwasser 9, 117. (1915)

P. Fanconnier* reports upon lead poisoning by the waters of Limousin.

*Bull. Soc. Pharm. Bordeaux, 53, 530-7.

Concerning the compounds of copper there are a variety of opinions. In the popular mind the idea that copper is a deadly poison is firmly fixed, yet it is a question upon which toxicologists and hygienists have been by no means unanimous. Copper and brass have been used since time immemorial in the manufacture of cooking utensils. Biblical and classical literature contains frequent references to them; and not only have numerous copper, brass, and bronze utensils been found in excavations in Europe and Asia, but upon this continent there is evidence that the copper deposits of Lake Superior were worked at an early period, and by a race probably differing from and possibly antedating the Indian. In the early part of the eighteenth century deaths caused by food articles, which were undoubtedly due to the then unknown products of putrefaction, were first attributed to their having been prepared in copper utensils, and were considered as cupric poisonings.

Passing over the discussion which was quite heated from 1875 to 1890 as to the danger of using copper as in the greening of canned goods, we come to the observations of Tschirch[1] and Lehmann,[2] that copper sulfate is not poisonous in

1. "Das Kupfer" Stuttgart, 1893.
2. Arch. f. Hyg., 1897, XXXI, 279.

small quantities. Later observations show that the constant absorption of copper by workers in that metal does not produce deleterious effects and is abundantly shown by numerous observations*,

*Honlis Jour. d'hyg., Paris, 1879, IV, 160, 170.
Buck "Hygiene" N.Y. 1879, II, 50, 51.
Index Cat. Libr. Surg.-Gen., Wash., III, 411.

altho they become saturated with it to such an extent that their hair and gums become green, and their urine colors the ground green.

Indeed, for practical purposes, copper must be considered as a normal constituent of the animal body. Its presence in the human subject has been frequently noted by toxicologists, in fact most human livers contain it. Quoting from Witthaus,*

*Medical Jurisprudence Forensic Medicine and Toxicology, Vol. IV, pp. 708.

"We find record of but three cases in which there is convincing evidence that death was caused by the ingestion of a copper salt.

One was Starr's* case of a woman suicide who died in four days and

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*Med. rec., 1882, XXI, 564.

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five hours from the effects of one ounce (30 grams) of cupric sulfate. Another was Wachholz's* case of another woman suicide who died of spasm of glottis soon after having swallowed a strong

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*Ztschr. f. Med. Beamte, 1893, VI, 397.

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solution of the sulfate. The third was von Maschka's* case of a

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* Wien. med. Wchnschr., 1871, XXI, 628.

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boy suicide, aet. 16, who died in seven days from the effects of a large dose of the sulfate."

E. Abel* reports that there is copper in nearly all

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*Z. Elektrochem. 19, 477-80.

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distilled water.

H. W. Clark* reports, that some of the reservoirs in

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*Mass. State Board of Health, 1905, 293.

Massachusetts, not known to have been treated with copper sulfate, contain copper in minute amounts. Small amounts of copper-bearing rock are found in the State, and large amounts of copper salts are used in spraying vegetation.

Same author* mentions 15 supplies in the state which

*Mass. State Board of Health Report, 1900, 488.

contain lead varying from .057 parts per million to 6.17 parts per million, and four supplies which contain copper varying from .076 parts per million to .47 parts per million. The author points to the fact that brass piping is used.

Concerning the commonly found constituents of water, but little has been written in a quantitative way. A. Bickel*

*Z. Balneol., 5, 275-80.
Wasser u. Abwasser, 6, 456-7.

concludes from animal experiments that mineral waters of high alkalinity, when taken on an empty stomach, causes a diminution of the gastric and pancreatic secretion and causes the mucous of the stomach to dissolve. The water with which he experimented was from Catharine spring in Borchom. It is one of the most strongly alkaline of Europe and in this respect is similar to the Vichy water. Its bicarbonate alkalinity ($NaHCO_3$) is 5216 parts per million.

H. Leo* reports that the sterile gall stones of man

*Deut. med. Wochschr., 40 , 740-6.

implanted in the gall bladder of dogs lose weight. When 300 cc. of Karlsbad water heated to 40° were given per oz. the loss of weight of the implanted stones proceeded more rapidly than in dogs not treated or in dogs receiving weekly alkaline sodium chloride solution.

A. Teohari and A. Babes* used a water containing 9.7

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*Bull. Acad. Roum., 1, 278-85 thru
Chem. Zentr., 1913, II, 448.

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grams NaCl and 9.7 grams $NaHCO_3$ per liter decreased the quantity of secretion and its acidity and pepsin content, while one containing 13.2 g. NaCl and 6.9 g. $NaHCO_3$ increased the quantity and the acidity.

The sulfates of potassium, sodium, and magnesium have an activity physiologically which is quite marked. The first mentioned sulfate is usually found in very small quantities, so that waters owe their laxative or purgative effect to magnesium sulfate or Epsom salt, and sodium sulfate, or Glaubers salt. Both of these salts increase the urinary flow.*

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*Mineral Waters of the United States and their
Therapeutic Uses, by Crook.

To obtain authoritative information as to allowable mineral constituents in water or to find anyone who is capable to give such advice is hard.

It is because of these difficulties and because of the minor sanitary importance of regulating the chemical impurities of water supplies that the formulation of chemical standards has been postponed by the commission appointed by the Secretary of the Treasury to fix standards for drinking water to be used on common carriers in interstate commerce.

The limits for bacteriological pollution are more important and simpler to formulate than those concerning the chemical constituents of a water. The danger arising from the use of a polluted water is probably never due to the organic matter in suspension, but to living organisms - bacteria. Therefore, it would seem for the detection of pollution that a bacteriological examination is of greater importance than a chemical analysis. It is no easy task to actually prove the presence of any disease-producing organisms and practically impossible to specifically prove their absence. One can get some idea as to whether the water is clean or dirty by an estimation of the number of bacteria. However, the quantity, is of prime importance. The most practical test of the purity of a water is the determination of the presence or absence of an intestinal bacterium, B. coli. This particular intestinal organism, if present, is easily found and identified, and since it is a normal inhabitant of the colon or large intestine of warm-blooded animals, it indicates pollution with animal excreta. Since practically all the infectious diseases known to be transmitted thru drinking water are due to organisms discharged in the intestinal excretions, the presence of pollution of this character may well be considered the most specific and significant evidence available concerning the sanitary quality of water. While this test indicates the presence of that kind of pollution which is generally conceded by bacteriologists to be most dangerous, it fails to give evidence of actual disease producing organisms.

The Commission prefaces their bacteriological standard for water by the following remarks: "The problem before the Commission has been to recommend limits of permissible impurities such as to meet the following requirement.

1. That water supplies conforming to the prescribed requirements shall be free from injurious effects upon the human body and free from offensiveness to the sense of sight, taste, or smell.

2. That supplies of the quality required shall be obtainable by common carriers without prohibitive expense.

3. That the examination necessary to determine whether a given water supply meets the requirements shall be as few and as simple as consistent with the end in view.

Compliance with the requirements herein recommended will insure a quality of water supplies equal to that of municipal supplies which have been demonstrated by experience to be entirely safe and satisfactory, and will at the same time impose no great burden upon common carriers, since it is entirely practicable, with moderate expense and pains, to purify water to the degree required.

In submitting the recommendations herewith presented it may be again emphasized that the limits defined are recommended solely to the special object of the control of the supplies of common carriers, having in mind that these supplies constitute a special case because of the following reasons:

1. The supplies come from widely diversified and mixed sources.

2. Samples taken from common carriers represent waters stored for various lengths of time under varying conditions.

3. In view of the impossibility of accurately ascertaining the source and history of each supply examined reliance must be placed upon results of laboratory examination to a greater extent than is necessary or justified in estimating the quality of a supply from a known source with a known history.

The following Bacteriological Standard for Drinking Water was adopted by the Treasury Department on October 21, 1914. The standard is one recommended by a commission appointed for the purpose by the Secretary of the Treasury, January 22, 1913.

1. The total number of bacteria developing on standard agar plates, incubated 24 hours at 37°C. shall not exceed 100 per cc. Provided that the estimate shall be made from not less than two plates, showing such numbers and distribution of colonies as to indicate that the estimate is reliable and accurate.

2. Not more than one out of five 10 cc. portions of any sample examined shall show the presence of organisms of the bacillus coli group when tested as follows:

(a) Five 10 cc. portions of each sample tested shall be planted each in a fermentation tube containing not less than 30 cc. of lactose peptone broth. These shall be incubated 48 hours at 38°C. and observed to note gas formation.

(b) From each tube showing gas more than 5% of the closed arm of the fermentation tube, plates shall be made after 48 hours' incubation upon lactose litmus agar or Endo's medium.

(c) When plate colonies resembling B. coli develop upon either of these plate media within 24 hours, a well-isolated characteristic colony shall be fished and transplanted into a lactose-broth fermentation tube, which shall be incubated at 37°C. for 48 hours.

For the purpose of enforcing any regulations which may be based upon these recommendations the following may be considered sufficient evidence of the presence of organisms of the Bacillus coli group.

Formation of gas in fermentation tube containing original sample of water (a). Development of acid-forming colonies on lactose litmus agar plates or bright red colonies on Endo's medium plates, when plates are prepared as directed above under (b).

The formation of gas, occupying 10 percent. or more of closed arm of fermentation tube, in lactose peptone broth fermentation tube inoculated with colony fished from 24-hour lactose litmus agar or Endo's medium plate.

These steps are selected with reference to demonstrating the presence in the sample examined of aerobic lactose fermenting organisms.

3. It is recommended as a routine procedure, that in addition to five 10 cc. portions, one 1 cc. portion and one .01 cc.

portion of each sample examined be plated in a lactose peptone broth fermentation tube, in order to demonstrate more fully the extent of pollution in grossly polluted samples.

4. It is recommended that in the above designated tests the culture media and methods used shall be in accordance with the specifications of the committee on standard methods of water analysis of the American Public Association, as set forth in "Standard Methods of Water Analysis". (A.P.H.A., 1912).

INVESTIGATION

Altho in the "Bacteriological Standard for Drinking Water" adopted by the Treasury Department for drinking water supplied to the public by common carriers in interstate commerce, it is especially emphasized that the limits defined are recommended with reference solely to the special object of the control of the supplies of common carriers, yet there is difficulty in explaining to the layman just why common carriers should further purify a water which is certified by the state officials and experts as being fit for drinking purposes.

There is a possibility that the Treasury Department requirement would work a hardship on some municipal plants supplying water to cities where the typhoid fever death rate is low. The men in charge of the water works do their best the year round to secure a good effluent, but an effluent up to the standard set by the Treasury Department is hard to obtain continuously. This is evidenced by the following citations from, "What is a Safe Drinking Water" by Allan J. McLaughlin, Surgeon United States Public Health Service.* In order to secure statistics from some

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*Public Health Reports, June 26, 1914.
Vol. 29, Part I, pp. 1686-1694.

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of our largest filtration and purification plants a circular letter was sent out by Surgeon McLaughlin to 40 cities. About 15 responded, and in most instances the statistics covered at least one year.

TABLE I.

Showing Average Number of Bacillus coli per 100 cc.
in Both Raw and Filtered or Treated Water of Certain Cities.

City	Number of Samples	Type of Filtration	Average number of B. coli per 100 cc.	
			Raw water	Filtered or Treated water
Toledo, Ohio	342	Mechanical Filtration	804	0.02
Minneapolis, Minn.	418	do	75	.1
Grand Rapids, Mich.	365	do	92	.3
Cincinnati, Ohio	240	do	1175	1.4
Birmingham, Ala.	205	do	196	1.0
	174	do	400	.2
Binghamton, N.Y.	420	do	59	1.2
Columbus, Ohio	365	do	606	1.3
Washington, D. C.	348	slow sand	2501	1.4
Providence, R. I.	600	do	732	4.3
Reading, Pa.	138	do	68	5.8
Baltimore, Md.	306	Alum and calcium hypochlorite	1349	2.5
Richmond, Va.	237	do	460	8.0

It will be noted that the last four cities in the table, taking the average by the Phelps method,* have more than

*Phelps, Earle B.--A method of calculating the number of B.coli from the results of dilution tests. Report and Papers of the Amer. Pub. Health Assn., V Vol. 33, 1907, pt. 2, pp. 9-13.

2 Bacillus coli per 100 cc. of water.

Picking months from the other cities in the table, there are found in this same article results as follows:

TABLE II.

Showing by Months Average Number of Bacillus coli

per 100 cc. in Both Raw and Treated Water.

Month City	No. of days Samples	Average Number of B. coli per 100 cc. Raw water	Filtered water
Cincinnati, Ohio.			
September, 1913	28	964	2.1
November, 1913	30	1990	2.7
December, 1913	B1	1841	3.0
Columbus, Ohio.			
April, 1913	30	921	2.3
May, 1913	31	196	1.9
July, 1913	31	378	5.1
Washington, D. C.			
January, 1913	25	4382	7.4
April, 1913	26	20,910	4.1
October, 1913	27	622	4.1
Birmingham, Ala. Cahaba Plant.			
May 22 - July 21, 1913	35	- 204	2.28
Dec. 1 - Dec. 30, 1913	14	- 323	4.2

It is probable that the samples taken on certain days from the four other plants at Toledo, Grand Rapids, Minneapolis, and Binghamton, mentioned in Table No. 1, that the standard of two B. coli per 100 cc. of water tested would not always be met.

The Standard adopted by the Treasury Department does not specificially state that there shall not be more than two B. coli per 100 cc., but does state that 50 cc. of water shall be tested and that there shall be not more than one tube containing 10 cc. giving a positive test for B. coli, which according to the Phelps method of counting, as used in the above reprint, would be the same as two B. coli per 100 cc. of water tested.

In the first progress report of the commission appointed to recommend Standards of Purity for Drinking Water supplied to the Public by Common Carriers Engaged in Interstate Traffic, on page 2966, Public Health Reports, November 6, 1914, this statement is found: "Compliance with the requirements herein recommended will insure a quality of water equal to that of municipal supplies which have been demonstrated by experience to be entirely safe and satisfactory and will at the same time impose no great burden upon the common carriers, since it is entirely practicable, with moderate expense and pains, to purify water to the degree required."

However, it would seem from careful analysis of the above tables that common carriers would find very few large municipal water purification plants in United States whose effluent at all times thruout the year they could receive directly into their coolers without further purification.

It seems unfortunate that the method of expressing results used in the above tables should be in vogue. A method which would give a more accurate idea of the condition of the water thruout the year would be to state the number of days that the water contained 1, 2, 3, etc., B. coli per 100 cc. Thus the fluctuation in quality may be studied to better advantage. The average result does not tell the whole story, for it eliminates

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the individual results, and a water supply should be safe and wholesome all of the time.

Suspecting that Illinois was not alone in the failure of some purification plants to meet the Treasury Standards, Director C. C. Young of the State Water Survey of Kansas was asked concerning the situation in Kansas. In response, he very kindly furnished the tables below and the following statement, "We do not believe that the filter plants in operation in this state can successfully meet these requirements. We have twenty-seven mechanical filter plants in operation, and most of these furnish water to the railroads. We have been largely instrumental in advising the cities to install these plants and if we failed to certify to these water on the basis of the Government Standard it would make a very embarrassing situation."

The results of bacteriological analyses tabulated below are divided into three classes: City supplies in Kansas where surface water is the source of supply; City supplies where ground water is the source of supply; Private ground waters owned by the railroads.

TABLE NO. III. Cities of Kansas, Surface Supplies.

Lab.No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations				
				Bacteria per cc.		Presumptive test for B. coli	No. of positive Fermentations	
				Gelatin 20°-48hrs.	Agar 37°-24hrs.		In 5 10 cc. tube	In 5 1 cc. tube
6561	Atchison, S.C.H.	City Supply	4-18-14	---	14	-	5-	5-
6778	" "	" "	6-30-14	15	15	+	2+3-	5-
6779	" "	" "	6-30-14	20	100	+	5+	5-
6780	" "	" "	6-30-14	240	100	+	2+3-	5-
6719	Cherryvale, M.F.	" "	6-25-14	16	55	+	4+1-	4+1-
6720	" "	" "	6-25-14	45	5	-	1+4-	5-
6722	Coffeyville,"	" "	6-25-14	150	85	+	4+1-	1+4-
6477	Emporia, S.C.	" "	2-24-14	liq.	60	+	2+3-	5-
6689	" "	" "	6-21-14	3500	200	+	5+	2+3-
6457	Fort Scott, S.C.H.	" "	2-21-14	3000	250	+	5+	1+4-
6746	" "	" "	8-28-14	250	300	+	1+4-	1+4-
6721	Independence, M.F.	" "	6-24-14	200	14	+	2+3-	5-
6549	Iola, S.C.H.	" "	4-14-14	1200	750	+	5+	3+2-
6611	" "	" "	5-11-14	200	35	+	5+	1+4-
5928	Kansas City, Ks. M.F.H.	" "	8-14-13	---	230	-	1+	5-
6755	Kansas City, Ks. M.F.H.	" "	6-29-14	500	120	+	5+	4+1-
6757	Kansas City, Ks. M.F.H.	" "	6-29-14	500	25	+	5+	5+
6760	Kansas City, Ks. M.F.H.	" "	6-29-14	400	125	+	5+	3+2-
6526	Kansas City, Mo. S.C.H.	" "	3-24-14	70	60	-	1+4-	5-
6761	Kansas City, Mo. S.C.H.	" "	6-29-14	150	25	+	2+3-	5-
7333	Kansas City, Mo. S.C.H.	" "	2-3-15	15	6	-	5-	5-
6421	Leavenworth, S.C.H.	" "	2-2-14	1200	2	-	5-	5-

TABLE NO. III. concluded.

Lab. No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations				
				Bacteria per cc.		Presumptive test for <u>B. coli</u>	No. of positive Fermentations	
				Gelatin 20°-48hrs.	Agar 37°-24hrs.		In 5 10 cc. tube	In 5 1 cc. tube
6789	Leavenworth, S.C.H.	City Supply	6-29-14	20	170	+	5+	1+4-
6770	" "	" "	6-30-14	58	370	+	5+	5+
6771	" "	" "	6-30-14	20	5	-	5-	5-
6772	" "	" "	6-30-14	42	50	+	5+	2+3-
7298	" "	" "	1-21-15	8	36	+	2+3-	5-
7328	Marysville, M. F.	" "	2-2-15	100	15	+	5+	1+4-
6707	Neodesha, M.F.	" "	6-23-14	350	300	+	4+1-	2+3-
6478	Osage City, M.F.	" "	2-24-14	liq.	20	-	5-	5-
6693	" "	" "	6-21-14	15	4	-	5-	5-
6472	Osawatomie, S.C.	" "	2-23-14	1000	30	+	4+1-	1+4-
6451	Ottawa, S.C.H.	" "	2-18-14	6500	80	+	4+1-	5-
6530	Parsons, S.C. (Storage) M.F.	" "	3-30-14	liq.	250	+	5+	1+4-
6744	Parsons, S.C. (Storage) M.F.	" "	6-27-14	liq.	20	+	5+	5-

The letters after the name of the city in the table carrying the surface waters have the following meaning: S = sedimentation; C = coagulation; H = hypochlorite; M.F. = mechanical filter.

After the publication of the standards by the Public Health Service only those tests for B. coli were considered positive when gas formation in lactose bile was confirmed. To use Mr. Young's own words, "Before that time we did not confirm tests as it has been our experience that the majority of fermentations in lactose bile would confirm."

Fifteen of the sixteen surface water supplies tabulated in Table No. 3 do not meet the "Treasury Standards" continuously with respect to the tests for B. coli. Of these fifteen, seven supplies did not meet the standard for count on agar at 37 1/2° for 24 hours as laid down by the "Treasury Standards." Seven of the above supplies are effluents from mechanical filters. Only three of the mechanical filter effluents exceed 100 colonies per cc. on agar. One supply, that of Osage City where a mechanical filter is in use, meets the standards in toto.

Fourteen of the 26 city ground water supplies (see Table No. IV) do not meet the "Treasury Standards" continuously with respect to tests for B. coli. Of these 14 supplies, 12 have an agar count of over 100 per cc. Of the 12 supplies which do meet the standard for B. coli there are 3 which have an agar count of over 100 per cc. Thus but 9 supplies meet the requirements in toto.

TABLE NO. IV. Cities of Kansas. Ground Supplies.

Lab. No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations				
				Bacteria per cc. Gelatin 20°-48hrs.	Bacteria per cc. Agar 37°-24hrs.	Presumptive test for B. coli	No. of positive Fermentations In 5 10 cc. tube	No. of positive Fermentations In 5 1 cc. tube
6695	Abilene	City Supply	6-22-14	60,000	250	-	5-	5-
6111	Anthony	" "	10-14-13	---	120	-	5-	5-
6776	Anthony	" "	6-30-14	500	150	+	5+	2+3-
6777	Anthony	" "	6-30-14	500	100	+	5+	1+4-
6551	Arkansas City	" "	4-14-14	100	180	+	3+2-	5-
6587	Arkansas City	" "	5-1-14	80	110	-	1+4-	5-
6782	Arkansas City	" "	6-30-14	450	100	-	1+2-	5-
6787	Arkansas City	" "	6-30-14	300	30	-	1+2-	5-
6368	Belleville	" "	1-21-14	800	35	+	5+	5-
6534	Belleville	" "	4-6-14	liq.	110	+	5+	5-
6753	Belleville	" "	6-29-14	30,000	1,000	+	5+	1+4-
6754	Belleville	" "	6-29-14	13,000	50	+	5+	3+2-
6359	Belleville	" "	2-8-15	160	5	-	1+5-	5-
6788	Caldwell	" "	6-30-14	2,000	3,100	+	2+	4+1-
6334	Concordia	" "	1-16-14	---	6	-	5-	5-
6335	Concordia	" "	1-16-14	---	4	-	5-	5-
6758	Concordia	" "	6-29-14	5,000	120	+	2+3-	1+4-
6759	Concordia	" "	6-29-14	800	14	+	2+3-	5-
6247	Conway Springs	" "	11-26-13	---	6	-	5-	5-
6740	Conway Springs	" "	6-27-14	35	2	-	5-	5-
6737	Dodge City	" "	6-27-14	2,000	230	-	5-	5-
6706	Eldorado	" "	6-22-14	14	10	-	5-	5-
7263	Eldorado	" "	1-10-15	65	3	-	5-	5-
6748	Greenleaf	" "	6-29-14	340	15	-	5-	5-
6344	Hanover	" "	1-17-14	60	15	-	1+4-	5-
6748	Hanover	" "	6-29-14	10	10	-	1+4-	5-
6750	Hanover	" "	6-29-14	30	5	+	2+3-	1+4-

TABLE NO. IV. continued.

Lab. No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations				
				Bacteria per cc.		Presumptive test for B. coli	No. of positive Fermentations	
				Gelatin 20°-48hrs.	Agar 37°-24hrs.		In 5 10 cc. tube	In 5 1 cc. tube
6593	Hutchinson	City Supply	5-1-14	1,000	5	-	1+4-	5-
6704	Hutchinson	" "	6-22-14	45	18	-	5-	5-
6339	Junction City	" "	1-16-14	---	12	+	2+3-	5-
6340	Junction City	" "	1-16-14	---	60	+	3+2-	5-
6692	Junction City	" "	6-21-14	55	9	+	2+3-	5-
6669	Junction City	" "	6-15-14	---	200	-	5-	5-
6691	Junction City	" "	6-21-14	34	6	-	5-	5-
7276	Junction City	" "	1-14-15	15	6	-	5-	5-
737	Lawrence	" "	4-25-14	2,500	1,200	+	---	2+3-
7280	Lawrence	" "	1-15-15	85	24	-	---	5+
7315	McPherson	" "	1-29-15	35	2	-	1+4-	5-
6009	Newton	" "	9-6-13	---	15	-	1+4-	5-
6358	Phillipsburg	" "	1-22-14	liq.	350	-	4+1-	5-
6736	Phillipsburg	" "	6-27-14	20,000	230	-	5-	5-
5857	Pittsburg	" "	7-27-13	---	50	+	4+1-	5-
6729	Pittsburg	" "	6-27-14	100	48	+	1+4-	1+4-
7290	Pittsburg	" "	1-15-15	liq.	40	-	1+4-	5-
6730	Pratt	" "	6-27-14	570	340	+	3+2-	2+3-
6690	St. Marys	" "	6-21-14	150	6	-	5-	5-
6337	Salina	" "	1-16-14	---	5	-	5-	5-
6338	Salina	" "	1-16-14	---	4	-	5-	5-
6699	Salina	" "	6-22-14	500	25	-	5-	5-
6700	Salina	" "	6-22-14	7	14	-	5-	5-
6698	Salina	" "	6-22-14	3000	500	-	5-	5-
7274	Salina	" "	1-14-15	800	500	+	3+2-	5-
6716	Stockton	" "	6-25-14	9	4	+	5+	5-
6687	Strong City	" "	6-21-14	100	360	-	5-	5-
6329	Topeka	" "	1-15-14	10	60	-	1+4-	1+4-

TABLE NO. IV. concluded.

Lab. No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations: Bacteria per cc. Gelatin 20°-48hrs.	Agar 37°-24hrs.	Presumptive test for B. coli	No. of positive Fermentations In 5 10 cc. tube	In 5 1 cc. tube
6330	Topeka	City Supply	1-15-14	12	30	-	5-	5-
6331	Topeka	" "	1-15-14	15	120	-	5-	5-
6764	Topeka	" "	6-30-14	50	50	-	1+4-	5-
6765	Topeka	" "	6-30-14	10	80	+	4+1-	5-
6766	Topeka	" "	6-30-14	2,600	4,000	+	4+1-	5-
6767	Topeka	" "	6-30-14	---	1,000	+	3+2-	5-
7329	Topeka	" "	2-2-15	800	10	-	5-	5-
6550	Wellington	" "	4-14-14	1,800	100	+	5+	5-
5908	Wichita	" "	8-6-13	---	250	+	1+4-	1+4-
6588	Wichita	" "	5-2-14	8	4	-	5-	5-
6783	Wichita	" "	6-30-14	25	160	-	3+2-	5-
6786	Wichita	" "	7-1-14	35	30	-	3-	5-

TABLE NO. V.

Cities of Kansas. Private Ground Supplies.

Lab.No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations: Bacteria per cc. Gelatin 20°-48hrs.	Agar 37°-24hrs.	Presumptive test for B. coli	No. of positive Fermentations In 5 10 cc. tube	In 5 1 cc. tube
6756	Argentine	Private	6-29-14	500	150	+	4+1-	3+2-
6708	Beaumont Jnc.	(Shipped from Enid, Okla.)	6-23-14	1,400	100	-	5-	5-
6552	Beloit	Private	4-14-14	400	450	-	1+4-	5-
6764	Beloit	"	6-29-14	13,000	1,400	-	1+4-	5-
7275	Beloit	"	1-14-15	6	4	-	5-	5-
6773	Belviderè	"	6-30-14	1,800	500	+	5+	5+
6738	Bucklin	"	6-27-14	5,500	750	-	1+4-	5-
6590	Caldwell	"	5-1-14	150	8	-	1+4-	5-
6727	Cedarvale	"	6-26-14	5,750	60	+	5+	4+1-
6465	Chanute	"	2-21-14	35	40	-	5-	5-
6469	Colony	(cistern)	2-23-14	3,200	15	+	3+2-	2+3-
6635	Council Grove	Private	5-23-14	60	100	-	5-	5-
6701	Council Grove	"	6-22-14	6,000	580	+	5+	4+1-
6548	Downs	"	4-15-14	400	3	-	5-	5-
6734	Downs	"	6-27-14	3,500	14	0	5-	5-
6728	Elgin	"	6-27-14	65	12	+	2+3-	5-
6601	Ellinwood	"	5-4-14	900	7	+	2+3-	1+4-
6341	Ellis	"	1-18-14	1,500	200	+	5+	4+1-
6342	Ellis	"	1-18-14	2,000	175	+	5+	5+
6531	Ellis	"	3-30-14	10	13	+	5+	3+2-
6670	Ellis	"	6-15-14	5,000	---	+	3+2-	5-
6994	Ellis	"	9-13-14	1,400	---	-	1+4-	5-
7102	Ellis	"	10-30-14	7	4	-	5-	5-
7141	Ellis	"	11-12-14	16	5	-	5-	5-
7266	Ellis	"	1-11-15	80	2	-	5-	5-

TABLE NO. V. Continued.

Lab. No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations: Bacteria per cc. Gelatin 20°-48hrs.	Agar 37°-24hrs.	Presumptive test for *B. coli*	No. of positive Fermentations In 5 10 cc. tube	In 5 1 cc. tube
6384	Ellsworth	Private	1-26-14	10,000	1,000	+	4+1-	1+4-
6695	Ellsworth	"	6-22-14	1,000	9	+	2+3-	5-
6775	Englewood	"	6-29-14	500	5	+	5+	2+3-
6475	Florence	"	2-23-14	1,200	10	+	5+	3+2-
6705	Florence	"	6-22-14	1,600	20	+	5+	3+2-
6369	Goodland	"	1-21-14	500	250	-	5-	5-
6739	Goodland	"	6-27-14	8,000	750	-	1+4-	5-
6751	Hardtner	"	6-29-14	4,300	150	+	5+	4+1-
7288	Hiawatha	"	1-18-15	30	12	+	2+3-	5-
7291	Highland	"	1-18-15	liq.	6	-	5-	5-
6606	Hoisington	"	5-4-14	4	5	-	5-	5-
6712	Hoisington	"	6-24-14	10,000	4	-	5-	5-
6724	Jetmore	"	6-26-14	5,000	35	-	5-	5-
6697	Kanopolis	"	6-22-14	1,000	20	+	5+	5+
6752	Kiowa	"	6-26-14	3,200	2,000	+	5+	1+4-
6711	Larned	"	6-24-14	5,000	25	-	5-	5-
6714	LeRoy	"	6-24-14	liq.	10	+	5+	4+1-
7401	Madison	"	2-27-14	300	400	+	5+	1+2-
6265	Manhattan	"	1-21-14	15	30	-	5-	5-
6688	Manhattan	"	6-21-14	8	3	-	5-	5-
7327	Manhattan	"	2-2-15	15	4	-	5-	5-
6703	Marquette	"	6-22-14	90	25	-	1+4-	1+4-
6366	Miltonvale	"	1-21-14	1,200	100	+	4+1-	1+4-
6677	Miltonvale	"	6-20-14	1,400	15	-	1+4-	5-
7273	Miltonvale	"	1-14-15	10	8	-	5-	5-
6745	Morgan	"	6-27-14	400	520	+	3+2-	5-
6580	Oberlin	"	4-27-14	4,000	9	+	3+2-	5-
6768	Oberlin	"	6-30-14	1,000	9,000	+	5+	4+1-

TABLE NO. V. Concluded.

Lab.No.	Cities	Kind of Supply	Analysis Completed	Bacterial Examinations: Bacteria per cc. Gelatin 20°-48hrs.	Agar 37°-24hrs.	Presumptive test for B. coli	No. of positive Fermentations In 5 10 cc. tube	In 5 1 cc. tube
6781	Onaga	Private	6-30-14	370	130	-	1+4-	5-
7325	Onaga	"	2-1-15	liq.	10	+	5+	2+1-
7425	Onaga	"	3-12-15	liq.	2	-	5-	2+3-
6717	Plainville	"	6-25-14	7,000	10	-	5-	5-
7268	Plainville	"	1-12-15	800	15	+	5+	1+4-
7424	Plainville	"	3-12-15	15,000	1	-	5-	2+3-
6731	Pratt	"	6-27-14	2,000	500	-	5-	5-
6747	Rich Hill	"	6-28-14	300	18	-	4+1-	1+4-
6577	St. Francis	"	4-27-14	200	5	-	5-	5-
6733	St. Francis	"	6-27-14	10,000	15	-	5-	5-
6336	Salina	"	1-16-14	---	3	-	5-	5-
6476	Strong City	"	2-23-14	1,400	4	+	5+	2+3-
6589	Wichita	"	5-1-14	10	7	-	5-	5-
6784	Wichita	"	6-30-14	85	70	-	2+3-	5-
6785	Wichita	"	6-30-14	25	40	-	2+3-	5-
6473	Yates Center	"	2-23-14	200,000	30	+	5+	5+
6713	Yates Center	"	6-24-14	liq.	6	+	2+3-	1+4-

Twenty-five of the 42 supplies above do not at all times meet the standard for B. coli. Of these 25, 12 supplies do not meet the standard for colony count on agar.

Of the 17 supplies which do meet the Treasury requirements in respect to B. coli there are 3 which do not meet the requirements for count on agar. Thus but 14 meet the requirements in toto. Out of a total of 84 supplies examined, 54 do not continuously meet the standard for B. coli; 37 have a count on agar in excess of 100 per cc. Of the 30 which do meet the B. coli standard there are 6 which do not meet the agar standard. Thus there are but 24 supplies of the 84 or 28.5% which meet the Treasury requirements in all respects. It is to be noted here that but one of these 24 was a surface supply; this purification plant is a mechanical filter, 9 were city ground water supplies, and the remaining 14 were ground supplies privately owned.

During the latter part of 1913 and early part of 1914 samples of water from 1000 cars were analyzed bacteriologically in the hygienic laboratory.* The samples were secured from the

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*Examination of Drinking Water on Railroad Trains, by R.H.Creel. Bull. No. 100, Hyg. Lab., Washington, D.C.

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coolers on trains arriving at Washington Station. The various waters examined originated from cities extending from Boston to Key West on the Atlantic Seaboard, and as far west as the Mississippi river.

The methods employed varied somewhat from those of the

Commission since the standard for purity of drinking water on common carriers had not yet been formulated while the work was in progress. The difference was in the tests for B. coli. Fermentation tubes of lactose broth were inoculated with 10 cc. and 5 cc. of the water for colon determination. A comparative series of lactose bile fermentation tubes inoculated with 10 cc. of the water were prepared at the time of inoculating the lactose broth. The presence of B. coli in a tube showing gas was determined by plating out on Endo's medium. At the time of making the Endo plate 1 cc. of the culture was planted into a melted, plain agar tube at about 75°C. Colonies on Endo plates when typically red with a sheen were recorded as positive for B. coli without further confirmation. If there were any doubts as to the colony being B. coli, inoculations were made into plain lactose broth fermentation tubes and results recorded from the latter. When the Endo plate was negative for B. coli and the agar tube, inoculated while hot, showed anaerobic growth with gas formation, the gas in originally inoculated fermentation tube was attributed to the presence of an anaerobic bacillus.

The striking result of the investigation from a bacteriological point of view was the preponderating number of gas forming anaerobes. Of 421 samples, which were positive for gas formation in lactose broth or in lactose bile fermentation tube when inoculated with 10 cc. quantities, B. coli was present only 91 times, the remaining samples having gas-producing anaerobic bacilli.

Relative frequency of B. coli in comparative series.

Water samples having B. coli	91
In lactose bile only, times	18
In lactose broth only, times	45
In both lactose broth and lactose bile, times	27

It is very apparent that lactose bile is very inhibitive to the growth of B. coli.

Relative frequency of gas-forming anaerobic bacilli in comparative series.

In lactose bile only	132
In lactose broth	125
In both lactose broth and lactose bile	89

No estimate can be made from this series as to the inhibiting action of lactose bile on the anaerobes, for the reason that two types of anaerobic bacilli were found--one that would never grow in lactose bile, either in massive doses of the pure culture or when mixed with aerobic commensals--another that would grow in plain lactose broth only when the culture tube had been thoroly exhausted of oxygen by steaming in Arnold sterilizer for one half hour.

It is to be noted in connection with the failure in the above article to confirm B. coli as being the agents of gas production in the lactose bile and lactose broth fermentation tubes that other investigators have found some difficulty in obtaining red colonies on Endo's medium with pure cultures of B. coli within 24 hours.*

*Rudolf Massini Archiv. für Hygiene 61, 250.

*That some definite idea of the character and composi-

*Examination of Drinking Water on Railway Trains, by Edward Bartow. J. Am. W. W. Assn. Vol. II, No. 1, March, 1915.

tion of water furnished to passengers on railway trains might be obtained 100 samples from water containers on trains have been collected and analyzed by members of the staff of the Illinois State Water Survey. The samples were secured from trains at Champaign, Urbana, Kankakee, and Chicago. Samples from cars coming from all parts of the country were secured; from Boston, New York, and other points in the East; Jacksonville, New Orleans, and Galveston, in the South; San Francisco, Los Angeles, and Denver, in the West; Minneapolis, Duluth, Sault St. Marie, in the North. The water is usually a mixture from several sources. The table indicates the points at which the tanks were last filled as it was impossible to learn the points from which all the water had been taken. The majority of samples, 57, were taken from coaches, 19 from sleepers, 8 from dining cars, 7 from smoking cars, 6 from parlor cars, 2 from tourist sleepers, and of 3 there was no record.

The analyses include both bacteriological and chemical examinations and an attempt has been made to make them as complete as possible when using 120 cc. samples for bacterial examination and one liter samples for chemical tests.

The analyses have been made as far as possible in accordance with Standard Methods of Water Analysis of the American Public Health Association (1912) and all analyses made after May 1 include confirmations of B. coli, made in accordance with the recommendations of the Commission on Standards for Common Carriers in Interstate Commerce.

For method of determining Turbidity see Standard Methods page 55; Color, Standard Methods page 8; Odor, Standard Methods page 8; Residue, Standard Methods page 30, but before weighing the residue was heated in an oven for one hour at 180°; Chlorine, Standard Methods page 42.

Magnesium. Neutralize 100 cc. of the water with N/50 sulfuric acid using methyl orange as indicator. Boil to expel carbon dioxide. Add 25 cc. of a saturated solution of lime water. Dilute to exactly 200 cc. with boiled distilled water. Cool and filter thru a dry filter paper rejecting the first 25 cc., titrate 50 cc. with N/50 sulfuric acid using methyl orange as indicator. Make a parallel determination using 100 cc. of pure distilled water. The number of cc. of N/50 acid required for the distilled water, minus the number of cc. of N/50 acid required for the sample times 9.6 equals parts per million of magnesium (Mg).

Alkalinity. Titrate 100 cc. of the water in a 200 cc. flask with N/50 sulfuric acid using first phenolphthalein and then methyl orange as indicators. The number of cc. of N/50 acid required times 10 equals parts per million of alkalinity in terms of

$CaCO_3$.

<u>Hardness</u>. To the 100 cc. neutralized in determining alkalinity add 10 cc. of soda reagent (a mixture of equal parts of approximately N/10 sodium hydroxide and N/10 sodium carbonate). Dilute with distilled water to exactly 200 cc. Allow to filter thru dry filter paper rejecting the first 25 cc. and titrate 50 cc. of the filtrate with N/50 sulfuric acid to the methyl orange endpoint. Make a parallel determination using 100 cc. of distilled water. The number of cc. of N/50 acid used for the distilled water less the number of cc. of N/50 acid used for the sample times 40 equals the number of parts per million of hardness as $CaCO_3$. When the number of cc. of acid required for the sample exceeds the number required for the distilled water, carbonates or bicarbonates of sodium or potassium are indicated.

<u>Iron</u>. Standard Methods page 45.

<u>Lead and Copper</u>. Use 100 cc. of water, add 2 grams pure crystals of ammonium chloride, 2 cc. acetic acid and 2 to 3 drops of 10% sodium sulfide (Na_2S) solution. Compare immediately with standards containing known amounts of lead nitrate. The standards should contain 0.01, 0.02, 0.03 mg. of Pb.

<u>Number of Bacteria per cc</u>. The total number of bacteria developing on gelatin incubated 48 hours at 20°. Standard Methods, 1905, page 82. Total number of bacteria developing on standard agar plates incubated for 24 hours at 37°C. See Public Health Reports, November 6, 1914, page 2960.

<u>B. coli</u>. See Public Health Reports, Nov. 6, 1914, page 2960.

Chemical Data

Number of samples examined		
99	No. having a turbidity of less than 10 P.P.M.	82
99	" " " color " " " 20 "	93
99	" " " residue " " " 500 "	95
99	" " " chlorine " " " 25 "	90
66	" " " magnesium " " " 20 "	60

If magnesium were all present as sulfate 20 parts per million of magnesium would be equal to 100 parts per million of $MgSO_4$.

Of 99 samples examined there was but one case of Alkalinity to Phenolphthalein. In no case was the Phenolphthalein Alkalinity greater than one half the Methyl Orange.

Number of samples examined		
66	No. showing an SO_4 content of less than 100	63
99	" " " Fe " " " " .5	86
66	" " no Cu or Pb (but one contained .3)	56

Bacteriological Data.

Fifty-three percent. of waters examined had an agar count of over 100 colonies per cc. at 37 1/2° for 24 hours.

Bacteriologically, those samples examined after May 1, 1914, were analyzed in strict accordance with the methods of analysis recommended by the Commission.

Twenty of the 67 waters were shown to be unsatisfactory

TABLE NO. VII.

Lab.No.	Town	Railroad	Source	Owernship		Turbidity	Color	Odor	Residue at 180°	Chlorine	Oxygen Consumed	Nitrogen as Free NH_3	Nitrogen as Alb. NH_3	Nitrogen as NO_2	Nitrogen as NO_3	Alkalinity M.O.	Ph	Bacteria per cc. on 37-1/2° Agar	20° Gelatin	Gas Formation in Lactose Broth 10cc. broth 10cc.	1cc.	.1cc.	40cc.broth 5-10cc. por. Pos.	Neg.	+ on Endo's	Confirmed	Not confirmed	Indol	Remarks
29469	Shawneetown	B.&O.	40' driven	Railroad														0	4	1-	2-	2-	5	0	5	4	1		Broken Chemical bottle
29470	Flora	"	30' dug	"		0	0	0	1806	275	2.8	.012	.108	.000	11.20	350		30	64	1+	2-	2-	4	1	4	2	2		
29471	Pana	"	16' "	"		0	0	0	1097	52	1.3	.012	.072	.002	8.00	170		45	liq.	1-	2-	2-	0	5	0	0	0		
29472	Springfield	"	wells	Municipal		15	5	1e	323	16	2.0	.036	.144	.002	.48	220		9	50	1-	2-	2-	0	5	0	0	0		
29476	Chester	Ill. So.	Miss. R.	Private	Ice	2	0	1e	46	4.2	4.8	.392	.246	.015	.48	4		4	9	1-	2-	2-	0	5	0	0	0		
29477	Alton	Mo.&I.B.&B.	"	Municipal	"	3	0	1 hypo	31	3.0	2.0	.632	.126	.015	.48	4		6	0	1-	2-	2-		not	run			-	
29478	"	"	"	"														50	6	1-	2-	2-		"	"			-	" " "
29481	Chester	Ill. So.	"	Private		30	3	2d	40	2.0	2.0	.800	.088	.002	.20	16		8	1	1-	2-	2-		"	"			-	
29482	"	"	"	"		35	5	4d	16	2.0	2.8	.604	.054	.001	.28	12		8	60	1-	2-	2-		"	"			-	
29499	Jacksonville	C.P.&St.L.	74' drilled	Railroad		3	10	1v	461	16.	1.2	.060	.046	.004	.40	298		2	4	1-	2-	2-	0	5	0	0	0		
29506	"	"			Ice	0	0	0	34	6.0	1.6	.146	.080	.007	.12	6		30	15	1-	2-	2-	0	5	0	0	0		
29512	Galesburg	C.B.&Q.	reservoir	Municipal		15 Fe	0	0	1004	79.	1.2	.400	.144	.030	.64	384		10	80	1-	2-	2-		not	run			+	
29513	"	"	"	"		10 Fe	5	0	1007	79.	1.2	.800	.240	.025	.80	384		30	130	1-	2-	2-		"	"			-	
29515	Pekin				Ice	3	0	0	26	2.0	1.3	.226	.050	.030	.04	4		8	15	1+	2-	2-	0	5	0	0	0	-	
29556	Springfield	C.H.&D.		Private	"	0	0	0	40	2.0	3.9	.230	.204	.030	.24	8		0	4	1-	2-	2-	0	5	0	0	0		
29563	Champaign			"	"	2	5	0	21	4.	2.5	.666	.122	.007	.20	6		60	180	1-	2-	2-	0	5	0	0	0	-	
29569	Matteson	I.C.	280' drilled	Railroad		0	10	0	626	2.	1.2	.568	.048	.000	.28	354		180	3000	1+	1+1-	2-	5	0	4	4	1	-	
29570	Monee	"	190' "	"		60	0	1 oily	545	2.	3.3	.600	.032	.016	.24	452		3	3	1-	2-	2-	0	5	0	0	0	-	
29571	Peotone	"	126' "	"		10	0	1b	625	5.	1.7	.520	.104	.003	.72	322		1	1	1-	2-	2-	0	5	0	0	0	-	
29592	Pittwood	C.&E.I.	120' "	"		40	30	0	325	25.	8.0	2.960	.224	.000	.24	288		0	6	1-	2-	2-	0	5	0	0	0	-	
29593	Coaler	"	139' driven	"		10	20	1v	376	26.	4.8	1.040	.160	.000	32.00	284		30	41	1-	2-	2-	0	5	0	0	0	-	
29594	Patineau	"	20' dug	"		10	5	0	358	31.	2.7	.056	.086	.000	.24	290		6	0	1-	2-	2-	0	5	0	0	0	-	
29599	Decatur				Ice	0	5	1w	16	3.	1.5	.154	.048	.004	.40	8		10	4	1-	2-	2-	0	5	0	0	0	-	
29600	Flora				"	3	5	0	31	5.	2.2	.292	.138	.004	.12	8		4	2	1-	2-	2-	0	5	0	0	0		
29601	St. Anne	"	210' drilled	"		45 Fe	0	0	902	7.	3.3	.800	.080	.023	.24	238		7	3	1-	2-	2-	3	2	3	2	1	-	
29606	Watseka	"	well	"		10	40	0	367	15.	5.2	3.200	.160	.000	.48	324		2	10	1-	2-	2-	1	4				-	One + tube broken.
29607	Steger	"	"	"		5	0	0	480	3.	.6	.254	.076	.000	.28	398		2	1	1-	2-	2-	0	5	0	0	0	-	
29610	Shawneetown	B.&O.	40' driven	"		0	0	0	560	34.	1.2	.008	.026	.005	1.08	260		11	9	1-	2-	2-	5	0	5	0	0	-	
29611	Flora	"	22' dug	"		0	0	0	1741	130.	1.5	.026	.070	.000	5.40	230		9	3	1-	2-	2-	0	5	0	0	0	-	
29614	Olney	C.H.&D.	12' "	"		0	0	0	703	55.	.8	.040	.062	.000	47.00	76		24	180	1-	2-	2-	4	1	4	2	2	-	
29623	"	"			Ice	0	5	1 oily	21	1.4	2.0	.170	.102	.008	.64	4		0	0	1-	2-	2-	0	5	0	0	0	-	
29637	Springfield	"	wells	Municipal		2	5	1v	357	19.	2.8	.038	.132	.000	.80	244		6	15	1-	2-	2-	3	2	3	3	0	-	
29638	Momence	C.&E.I.	100' drilled	Railroad		2	5	0	531	20.	2.5	.024	.088	.004	.60	240		2	2	1+	2-	2-	0	5	0	0	0	-	
29639	Chicago Hts.	"	well	"		2	3	0	700	7.	1.0	.224	.080	.004	.72	378		9	4	1-	2-	2-	0	5	0	0	0	-	
29653	Kankakee	Big 4 & I.C.			Ice	0	0	1w	17	.8	2.2	.112	.236	.007	.92	6		5	2		2-	2-	0	5	0	0	0		
29666	Effingham				"	0	0	"	20	.8	1.5	.234	.084	.007	.40	8		4	2		2-	2-	1	4	0	0	0		
29676	So. Holland	C.&E.I.	L. Mich.			2	5	1e	166	4.	2.0	.020	.078	.000	.44	120		1	150	1-	2-	2-	0	0	5	0	0		
29704	Crete	"	200' drilled			2	10	0	431	4.	1.0	.208	.088	.000	.24	394		125	1600	1+	1+1-	2-	3	2	3	3	0	-	
29715	Cypress	"	20' dug			0	0	0	309	22.	.8	.030	.122	.000	3.20	216		0	500	1-	2-	2-	0	5	0	0	0		
29716	Mt. Vernon	"	tap	Municipal		2	20	1e	324	12.	3.6	.164	.164	.001	.76	44		35	200	1-	2-	2-	0	5	0	0	0	-	
29717	Marion	"	deep well	"		2	10	1v	1573	420.	1.6	.014	.052	.000	1.12	700	2	230	700	1-	2-	2-	0	5	0	0	0	-	
29718	Joppa	"	80' driven	Railroad		2	10	0	220	20.	1.2	.036	.048	.000	.80	184		10	1	1-	2-	2-	0	5	0	0	0	-	
29719	Matteson	I.C.	280' drilled	"		2	10	0	621	5.	1.0	.560	.064	.000	.36	344		3	20	1-	2-	2-	1	4	0	0	0	-	
29720	Thebes	C.&E.I.	Miss. R.	"		400	20	2v	637	16.	9.4	.240	.400	.015	1.08	158													No bacterial run.
29722	W. Frankfort	"	18' bored	"		45	3	1v	1608	36.	1.7	.034	.132	.002	6.40	58		800	1200	1-	2-	2-	0	5	0	0	0	-	
29723	Forrest	"	16' dug	"		2	5	1d	1660	35.	.7	.002	.066	.000	10.00	316		12	90	1+	2-	2-	0	5	0	0	0		

TABLE VII. (continued)

Lab.No.	Town	Railroad	Source	Ownership	Turbidity	Color	Odor	Residue at 180°	Chlorine	Oxygen Consumed	Nitrogen as Free NH_3	Nitrogen as Alb. NH_3	Nitrogen as NO_2	Nitrogen as NO_3	Alkalinity M.O.	Ph.
29737	Staunton	Wabash	16' dug	Railroad	5	15	1v	1752	40	1.7	.120	.110	.246	2.40	316	
29747	Bement	"	140' driven	"	10	15	1e	574	30	5.6	2.400	.200	.005	.40	474	
29759	Danville			Ice												
29794	Villa Grove	C.&E.I.	46' bored	"	10	0	1e	1956	73	2.3	.020	.058	.007	15.2	156	
29795	Cairo	"	tap	"	40	0	2v	156	7	2.2	.084	.072	.000	1.40	28	
29796	Pinkneyville	"	20' dug	"	0	0	0	1466	300	1.0	.022	.082	.000	3.12	280	
29797	Eldorado	"	cistern	"	7	35	1v	1898	220	10.0	.102	.618	2.70	148.0	176	
29798	Centralia	"	tap	"	30	8	1e	169	5	3.2	.078	.252	.000	1.08	42	
29799	Carbondale	"	600' drilled	"	5	0	0	2512	1200	2.9	.048	.064	.000	1.20	378	8
29800	Golconda	"	cistern	"	5	15	2e	89	4	4.0	.026	.056	.000	.56	24	
29803	Chicago	Penn.	hydrant	Municipal												
29804	"	"	"	"												
29805	"	"	sleeper													
29806	"	"	"													
29807	"	"	"Edge Cliff"													
29808	"	"	Coach 7003													
29809	"	"	Hygienic Ice co.	Ice												
29810	"	"	"	"												
29842	Salem	C.&E.I.	99' drilled	Railroad	0	0	1e	2893	49	2.9	.074	.098	.000	.20	448	
29843	Mitchell	"	86' driven	"	70Fe	0	1e	358	8	1.2	.204	.016	.000	.48	258	
29844	Olney	C.H.&D.	16' dug	"	3	10	0	577	92	3.6	.040	.244	.000	22.00	68	
29873	Shawneetawm	B.&O.	40' driven	"	0	0	0	490	13	1.0	.006	.090	.000	.56	310	
29874	Dollville	C.&E.I.	14' dug	"	0	0	1d	335	21	1.0	.006	.048	.000	9.20	192	
29875	"	"	16' bored	"	3	0	1d	462	19	1.0	.076	.120	.000	6.00	192	
29876	"	"	16' dug	"	3	5	1d	400	28	2.8	.272	.306	.135	11.20	162	
29888	Bloomington	I.C.	150' drilled	"	5	75	2v	330	2	7.1	1.600	.264	.000	.00	306	
29909	Pana	C.&E.I.	17-1/2' dug	"	0	10	0	2379	340	2.2	.000	.190	.013	32.00	269	
29910	"	"	S. W.	Municipal	15	5	1e	1054	170	1.4	1.116	.066	.017	.80	404	
29911	"	"	19' dug	Railroad	0	5	0	905	130	1.4	.052	.112	.000	15.60	104	
29912	"	"	18-1/2' dug	"	0	5	1v	1107	106	1.2	.072	.158	.000	15.20	256	
29913	German Valley	C.&G.W.	40' drilled	"	0	0	0	321	6	1.8	.020	.088	.000	4.00	260	
29914	So. Freeport	"	310' "	"	10	0	0	397	6	.9	.560	.064	.000	.00	324	
29915	Byron	"	530' "	"	5	0	2 oily	297	5	1.5	.112	.048	.000	.40	302	
29916	Elgan	"	75' "	"	0	0	1e	300	4	.5	.032	.036	.003	5.20	242	
29917	Myrtle	"	60' "	"	0	0	0	442	23	.5	.064	.096	.000	20.00	242	
29925	Henton	C.&E.I.	16' bored	"	0	0	0	375	26	.8	.008	.044	.000	6.40	252	
29926	Thornton	"	20' dug	"	0	0	0	990	51	1.2	.070	.126	.007	1.92	324	
29927	Salem	"	20' "	"	30	5	1e	775	7	1.5	.024	.080	.002	2.20	460	
29951	Lindenwood	C.&G.W.	28' "	"	0	0	1v	409	14	1.0	.028	.042	.000	.80	270	
29952	Halcomb	"	80' drilled	"	3	0	1e	370	10	1.0	.024	.042	.000	.40	298	
29953	Stillman Val.	"	58' "	"	0	0	0	376	6	.9	.026	.020	.045	.64	304	
29954	Esmond	"	25' dug	"	0	10	0	2159	135	3.2	.060	.186	.040	85.00	284	
29955	Sycamore	"	900' drilled	Municipal	20	0	1e	343	5	1.5	.320	.080	.000	.72	330	
29956	Virgil	"	12' driven	Railroad	35Fe	10	0	896	33	1.4	.074	.114	.000	.20	328	
29957	St. Charles	"	80' drilled	"												
29958	Clare	"	14' dug	"												
29963	Findlay	C.&E.I.	dug well	"	3	5	1a	1381	92	.8	.022	.094	.002	18.80	244	
29964	Lilly Lake	C.&G.W.	80' drilled	"												
29974	Bluffs	Wabash	30' driven	"	0	0	0	488	18	2.0	.000	.040	.015	.72	434	

Lab.No.	Bacteria per cc. on 37-1/2° Agar	Bacteria per cc. on 20° Gelatin	Gas Formation in Lactose Broth, 10cc. broth 10cc.	1cc.	.1cc.	40cc. broth 5-10cc. por. Pos.	Neg.	+ on Endo's	Confirmed	Not Confirmed	Indol	Remarks
29737	110	200	1-	2-	2-	0	5	0	0	0	-	
29747	12	9	1-	2-	2-	0	5	0	0	0		
29759	0	0		2-	2-	0	5	0	0	0		
29794	9	195	1-	2-	2-	0	5	0	0	0		
29795	19	13	1-	2-	2-		not	run			-	
29796	93	170	1-	2-	2-	0	5	0	0	0	+	
29797	2000	5000	1+	2+	1+1-	5	0	5	5	0	+	
29798	30	102	1-	2-	2-	0	5	0	0	0		
29799	18	52	1+	1+1-	2-	2	3	2	1	1	+	
29800	8	1	1-	2-	2-	0	5	0	0	0	-	
29803	5	150	1-	2-	2-	2	3	2	2	0	+	
29804	18	260	1-	2-	2-	1	4	1	1	0	+	
29805	650	1300	1-	2-	2-	0	5	0	0	0	-	
29806	7	2	1-	2-	2-	1	4	1	0	1	-	
29807	1100	760	1-	2-	2-	0	5	0	0	0	-	
29808	750	1600	1-	2-	2-	0	5	0	0	0	-	
29809	4	1		2-	2-	0	5	0	0	0	-	
29810	18	12		2-	2-	0	5	0	0	0		
29842	600	1200	1+	1+1-	1+1-	0	5	0	0	0	-	
29843	1	0	1-	2-	2-	0	5	0	0	0	-	
29844	200	450	1+	2+	1+1-	5	0	5	5	0		
29873	10	9	1-	2-	2-	2	3	2	2	0	-	
29874	86	530	1+	2+	2-	1	4	1	1	0	+	
29875	250	3000	1+	2-	2-	2	3	2	1	1	+	
29876	14	140	1+	2+	2-	2	3	2	2	0	+	
29888	5000	3500	1+	2+	2-	4	1	4	3	1	-	
29909	9	12	1-	2-	2-	1	4	1	1	0	+	
29910	0	0		2-	2-	3	2	3	2	1		
29911	12	30	1-	2-	2-	4	1	4	4	0		
29912	15	69	1-	2-	2-	0	5	0	0	0		
29913	lost	2	1-	2-	2-	0	5	0	0	0		
29914												Not run
29915	180	lost		2+	1-1+	5	0	5	5	0		
29916	3	20	1-	2-	2-	0	5	0	0	0		
29917	0	69	1-	2-	2-	0	5	0	0	0		
29925	0	21	1-	2-	2-	0	5	0	0	0		
29926	600	5000		2-	1+1-	4	1	4	3	1		Uniced
29927	570	1450	1+	1+1-	2-	3	2	3	1	2	-	
29951	9	98	1-	2-	2-	2	3	2	1	1	-	
29952	2	0	1-	2-	2-	0	5	0	0	0	-	
29953	1	0	1-	2-	2-	0	5	0	0	0	-	
29954	120	870	1+	2-	2-	0	5	0	0	0		
29955	5	2	1-	2-	2-	0	5	0	0	0	-	
29956	1	3		2-	2-	2	3	2	2	0	-	
29957	36	410		2-	2-	1	4	1	1	0		
29958	176	210		1+1-	1+1-	5	0	5	5	0		
29963	120	880	1+	1+1-	2+	4	1	4	4	0	-	
29964	21	130		2-	2-	0	5	0	0	0	-	
29974	3	0	1-	2-	2-	0	5	0	0	0		

TABLE NO. VII. (concluded)

Lab.No.	Town	Railroad	Source	Ownership	Turbidity	Color	Odor	Residue at 180°	Chlorine	Oxygen Consumed	Nitrogen as Free NH_3	Nitrogen as Alb. NH_3	Nitrogen as NO_2	Nitrogen as NO_3	Alkalinity	Bacteria per cc. on Agar 37-1/2°	Bacteria per cc. on Gelatin 20°	Gas Formation in Lactose Broth, 10cc. broth: 10cc.	10cc. broth: 1cc.	10cc. broth: .1cc.	40cc. broth 5-10cc. per: Pos.	40cc. broth 5-10cc. per: Neg.	+ on Endo's	Confirmed	Not Confirmed	Indol	Remarks
29975	Thornton	C.&E.I.	150' drilled	Railroad	0	5	1v	332	6	2.5	.132	.110	.010	8.00	120	6	310	1+	2-	2-	0	5	0	0	0	-	
29976	Jacksonville		well	Private												2500	1500	1+	1+1-	2-	0	5	0	0	0	-	
29977	Brewer	"	85' "	Railroad	30 flakes	25	le	532	4	8.1	4.280	.298	.005	.44	426	28	36	1-	2-	2-	0	5	0	0	0		
29978	Westville, Ind.	Wabash			Ice 3	0	1a	19	4	2.0	.114	.140	.003	.24	8	12	2	1-	2-	2-	0	5	0	0	0		
30000	Bronson	C.&E.I.	20' dug	"	0	0	0	767	75	1.0	.000	.060	.003	15.20	136	44	80	1-	2-	2-	not	run				+	
30006	Long View	"	700' drilled	"	30	35	1v	1326	500	9.4	9.600	.304	.000	.08	508	9000	5000	1-	2-	2-	3	2	3	3	0	-	
30010	Mt. Vernon	Southern		Municipal	0	0	1d	266	10	2.3	.080	.140	.000	.76	36	6	200	1-	2-	2-	3	1	2	2	1	+	
30011	Broadlands	C.&E.I.	49' dug	Railroad	3	5	0	504	22	1.2	.008	.056	.000	1.20	230	8	90	1-	2-	2-	3	2	3	2	1	-	
30012	Broadlands	"	60' "	"	0	0	0	910	17	1.2	.012	.060	.002	4.20	184	44	115	1-	2-	2-	5	0	5	2	3	-	
30026	Marion	"	400' bored	Municipal	2	10	le	1494	360	2.3	.048	.056	.005	.80	740	1	5000	1-	2-	2-	5	0	5				lost Lactose broth tub
30028	Wasco	C.&G.W.	50' drilled	Railroad	30	0	1m	1047	118	.7	.044	.076	.000	.36	310	8	150		2-	2-	4	1	4	1	3	+	
30029	Lilly Lake	"	80' "	"	0	0	0	542	11	1.5	.040	.100	.000	7.60	378	4	96		2-	2-	1	4	1	0	1	-	
30030	St. Charles	"	80' "	"	0	0	0	473	16	1.0	.014	.086	.000	5.20	284	4	80	1-	2-	2-	5	0	5	2	3	-	
30032	Lombard	"	125' "	"	20Fe	0	0	431	4	.9	.200	.040	.000	.20	396	0	33		2-	2-	0	5	0	0	0	-	
30033	Gretna	"	150' "	"	20	0	le	325	4	2.1	.320	.048	.000	.16	174	4	0		2-	2-	0	5	0	0	0	-	
30034	Ingalton	"	127' "	"	3	0	0	383	4	.8	.240	.072	.000	.44	352	0	0		2-	2-	0	5	0	0	0	-	
30035	Forest Park	"	artesian well	Municipal	0	0	le	636	85	.7	.216	.112	.020	.32	262	0	2		2-	2-	2	3	2	2	0	-	
30036	Elmhurst	"	spring	Railroad	5Fe	0	0	483	4	.8	.276	,096	.000	.28	340	6	3	1-	2-	2-	0	5	0	0	0	-	
30037	No. Glen Ellyn	"	60' dug & dr.	"	3	0	le	452	4	1.3	.132	.126	.000	.24	334	0	2	1-	2-	2-	0	5	0	0	0	-	
30038	Chicago	"	tap	Municipal	15	5	1m	154	6	1.0	.024	.110	.000	.32	120	2	1	1-	2-	2-	3	2	3	0	3	-	
30039	So. Freeport	"	310' drilled	Railroad	20	0	le	397	7	1.1	.400	.056	.000	.20	326	370	4000		2-	2-	0	5	0	0	0	-	
30040	Bolton	"	180' drilled	"	10	0	2g	294	4	1.6	.600	.120	.000	.24	294	9	180		2-	2-	0	5	0	0	0	-	
30047	Pearl City	"	42' "	"	12	30	le	629	66	.7	.836	.108	.012	.88	374	4	6	1-	2-	2-	not	run				-	
30051	St. Elmo	C.&E.I.	20' dug	"	0	0	2m	995	48	1.0	.004	.060	.000	5.00	282												Bacterial not run
30064	Byron	C.&G.W.	481' d. and d.	"	0	0	0	395	8	.6	.072	.064	.000	.72	302	0	45	1-	2-	2-	1	4	1	1	0		
30067	Thebes	C.&E.I.	water tank	"	340	10	le	497	8	9.4	.198	.338	.004	2.40	110	1500	5000	1+	2+	1+1-	0	5	0	0	0	+	
30071	Bluffs	Wabash	30' bored	"	3	15	1v	453	15	1.2	.022	.058	.000	.76	436	1	2	1-	2-	2-	0	5	0	0	0		
30094	Marion	C.I.P.S.Co.	600' driven	Private	Ice 0	0	1m	28	1	5.4	.132	.310	.003	.16	6	12	36		2+	1+1-	5	0	5	5	0	+	
30125	W. Frankfort	C.&E.I.	25' dug	Railroad	8Fe	0	1v	994	44	1.0	.016	.068	.011	80.00	320	90	250	1-	2-	2-	5	0	5	5	0	-	
30126	Roodhouse	C.&A.	190' drilled	"	120Fe	0	le	483	9	1.2	1.000	.200	.000	.12	436	1	0		2-	2-	0	5	0	0	0	-	
30127	Custer	"	48' dug	"	200	15	1v	1185	22	8.0	.728	.240	.017	.12	336	431	9300		2+	1+1-	4	1	4	3	1		
30128	Glenn	"	90' drilled	"	25Fe	0	le	861	17	1.2	.324	.088	.000	.20	96	0	0		2-	2-	0	5	0	0	0	-	
30129	Brighton Park	"	Lake Mich.	Municipal	25	0	2v	179	5	1.3	.026	.102	.000	.28	106	10	111		2-	2-	1	4	0	0	1	-	
30131	Carlinville	"	18' dug	Railroad	10	0	le	1187	168	.9	.014	.044	.000	5.60	264	13	120	1+	2-	2-	1	4	1	1	0	-	
30158	Marion	C.I.P.S.Co.			Ice 0	0	0	12	2	2.0	.100	.078	.006	.12	14	7	16		2-	2-	0	5	,0	0	0	+	
30195	Thornton Jnc.	C.&E.I.	30' dug	"	7	10	2d	1192	62	.5	.024	.094	.045	1.80	334	34	80	1+	2-	2-	2	3	1	1	1	+	
30295	Lockport		43' "	"	2	0	0	1469	118	1.8	.034	.158	.010	5.60	280	960	1300	1-	2-	2-	5	0	4	3	2	+	
30332	Galena Jnc.	C.&G.W.	45' drilled	"	7	0	0	431	25	1.3	.026	.090	.000	1.12	342	120	8000	1+	2+	2-	5	0	5	5	0		
30333	Aiken	"	147' "	"	7	5	0	358	5	.7	.120	.080	.000	.16	352	1	---		2-	2-	0	5	0	0	0		
30334	Rodden	"	? "	"	5	0	0	393	12	1.0	.020	.040	.000	1.08	300	20	200		1-	2-	5	0	5	3	2		
30335	Hanover	"	spring	"	2	0	0	974	85	1.0	.046	.048	.000	11.00	316	50	750	1-	2-	2-	0	5	0	0	0		
30336	"Fan House"	"	"	"	10	0	0	298	8	1.5	.028	.084	.000	.72	234	150	2500	1+	2+	2-	5	0	5	3	2		
30337	Winston	"	"	"	0	0	2m	208	4	.9	.044	.094	.000	3.20	176	70	4000		2-	2-	0	5	0	0	0		
30379	E. Stockton	"	430' deep	"	0	0	0	324	12	.8	.120	.144	.000	.60	288	1500	----		2-	2-	0	5	0	0	0	-	
30380	Elizabeth	"	400' "	Municipal	0	5	0	538	35	.7	.048	.088	.015	.44	568	6	17		2-	2-	0	5	0	0	0		
30381	Woodbine	"	155' "	Railroad	20	20	0	861	110	.6	.048	.056	.010	10.00	280	30	9		2-	2-	0	5	0	0	0		
30382	Kent	"	? drilled	"	8	25	1v	244	18	6.0	.056	.144	.000	3.80	138	1700	liq.		2+	2+	5	0	5	5	0		
30383	Stockton	"	1500' "	Municipal	0	0	0	311	2	.6	.040	.056	.000	.60	210	14	99		2-	2-	3	2	3	3	0		
30400	Roodhouse	C.&A.	deep well	Railroad	10	30	0	318	13	1.5	.056	.080	.002	.60	226	42	24	1-	2-	2-	0	5	0	0	0		
30403	Goodwine	C.&E.I.	60' drilled	"	18	15	0	473	7	2.0	1.190	.056	.000	.08	560	6	3	1-	2-	2-	0	5	0	0	0		

TABLE NO. VI.

Samp. No.	Date of collection	1913	Collector	City	Railroad	Train No.	Car	Tank filled at	Turbidity	Color	Odor	Residue	Chlorine	Alkalinity	Iron	Bacterial count Gelatin	Bacterial count Agar	B. coli in Lactose Broth Special 10 cc.
1	Dec.	29	H.*	Champaign	I.C.	2	Diner	Hammond, La.+	2	0	0	182	3	96	.3	30,000	8,000	5-
2	"	29	"	"	"	2	Coach 28	Memphis	0	0	0	19	0	12	.0	280	14	5-
3	"	29	"	"	"	2	" 3127	Centralia	1	0	0	344	23	92	.0	187	5	2+ 3-
4	"	30	"	"	I.T.S.		"		1	0	0	18	0	10	.0	125	18	5-
5	"	30	"	"	Big 4	16	" 644	Peoria	3	0	0	80	27	20	.0	---	13	2+ 3-
6	"	30	"	"	Wabash	36	Smoker	Champaign	8	20	0	426	0	356	.6	10,000	1,500	5-
7	"	31	"	"	I.C.	1	Diner	Hammond, La.+	2	0	0	191	4	96	.2	15,000	10,000	4+ 1-
8	"	31	"	"	"	1	Sleeper	Chicago	15	20	0	147	1	94	.4	1,500	510	3+ 2-
9	"	31	"	"	"	1	Coach 2109	"	10	5	0	159	3	96	.0	54	23	5-
		1914																
10	Jan.	5	T.*	"	"	1	Diner	Hammond, La.+	2	0	0	205	10	100	.3	1	4	5-
11	"	5	"	"	"	1	Coach	Chicago	5	0	0	357	50	76	.0	600	61	3+ 2-
12	"	5	"	"	"	1	"	"	20	5	0	170	3	108	.1	90	36	3+ 2-
13	"	5	"	"	"	24	Smoker	Centralia	3	0	0	148	32	28	.0	20	15	1+ 4-
14	"	5	"	"	"	24	Coach	"	0	0	0	42	2	26	.0	160	75	5-
15	"	5	"	"	"	24	"	Effingham	0	0	0	150	12	84	.0	61	24	5-
16	"	5	H.*	Kankakee	C.I.&S.		"	South Bend, Ind.	0	0	0	331	10	216	.0	140	30	5-
17	"	7	T.*	Champaign	Big 4	16	"	Peoria	7	3	0	526	22	268	2.5	36	14	5-
18	"	7	"	"	"	16	"	"	7	0	0	524	2	260	.0	52	19	1+ 4-
19	"	12	M.*	Chicago	I.C.	18	Buffet	Springfield	5	5	0	43	8	8	2.0	60	13	5-
20	"	12	"	"	"	18	Sleeper	Parsons, Kan.	0	0	0	29	3	12	.0	140	200	5-
21	"	12	"	"	Big 4	31	Parlor car	Cincinnati, O.	5	0	0	25	2	10	.05	10,000	2,500	5+
22	"	12	"	"	"	31	Sleeper	"	0	0	0	163	6	36	.0	300	220	5-
23	"	12	"	"	"	43	Coach	"	2	0	0	102	9	24	.05	50	10	1+ 4-
24	"	12	"	"	"	43	Sleeper	"	12	0	0	91	15	36	.0	400	54	1+ 4-
25	"	12	"	"	Soo	2	Diner	Waukesha, Wis.+								3,500	300	5-
26	"	19	S.*	"	C.&E.I.	21	Car 492		3	0	0	161	24	62	.1	1,100	69	2+ 3-
27	"	19	"	"	Santa Fe	9	Tourist	Chicago								790	40	1+ 4-
28	"	19	"	"	"	9	Diner	"	2	0	0	458	16	278	.2	18	3	5-
29	"	19	"	"	"	6	Smoker	Ft. Madison, Ia.	5	0	0	95	4	38	.0	6,000	46	5-
30	"	19	"	"	C.&E.I.	9	Car 432	Chicago	20	5	0	125	4	86	.2	1,000	130	2+ 3-
31	"	19	"	"	"	6	" 976	Nashville, T.	0	0	0	85	4	46	.0	50,000	6	5-
32	"	19	"	"	Erie	47	Sleeper	Salamanca, N.Y.	20	5	0	114	4	78	.6	500	24	1+ 4-
33	"	19	"	"	"	47	Car 1037	"	2	10	0	37	4	14	.1	23	4	5-
34	"	19	"	"	Wabash	50	" 1082	Forest, Ill.	25	35	0	48	4	16	1.9	5,000	20	5-
35	"	19	"	"	"	7	Sleeper	Montreal	20	20	0	125	6	76	.0	710	100	5-

*Collections have been made by W.W.Hanford (H), F.W.Tanner (T), F.W.Mohlman (M), and C.H.Spaulding (S).

+Denotes bottled water.

TABLE VI. (continued)

Samp. No.	Date of Collection 1914	Collector	City	Railroad	Train No.	Car	Tank filled at	Turbidity	Color	Odor	Residue	Chlorine	Magnesium	Alkalinity $CaCO_3$ Ph.	Alkalinity $CaCO_3$ M. O	Hardness $CaCO_3$	Sulfate	Iron	Copper and Lead	Bacterial count Gelatin	Bacterial count Agar	B. coli Gas formation 10 cc. L.B.	B. coli Gas formation 10 cc. Conf.
36	May 6	M.*	Chicago	M.C.	7	Sleeper	Grand Rapids	10	5	0	170	5	8.6	4.	72	112	35.	.0	.0	300	200	5-	5-
37	" 6	"	"	"	7	"	Detroit	8	10	0	118	7	4.8	---	54	48	13.6	.2	.1	9	10	2+ 3-	2+ 3-
38	" 6	"	"	Big 4	31	"	Cincinnati	2	0	0	28	0	0.	---	7	8	0.	.4	.05	850	600	5-	5-
39	" 6	"	"	I.C.	10	"	Memphis	5	0	0	113	4	4.8	---	76	72	4.9	.0	.15	700	1,000	3+ 2-	5-
40	" 6	"	"	"	12		Sioux City, Ia.	15	5	0	298	6	18.2	---	188	196	34.7	.2	.05	50,000	125	1+ 4-	5-
41	" 6	"	"	Big 4	3	Diner	Buffalo	10	10	0	165	4	3.8	---	100	88	11.9	.15	.0	950	35	4+ 1-	4+ 1-
42	" 6	"	"	I.C.	30	Sleeper	St. Paul	0	0	0	31	0	0.	---	5	4	0.	.1	.0	10,000	1,800	5-	5-
43	" 6	"	"	M.C.	13		Detroit	2	3	0	27	0	0.	---	10	4	0.	.4	.0	400	200	2+ 3-	2+ 3-
44	" 6	"	"	"	13	Tourist	Boston	2	0	0	20	0	0.	---	5	8	0.	.5	.0	30	5	5-	5-
45	" 6	"	"	I.C.	28	Parlor car	Dubuque, Ia.	2	0	0	123	5	9.6	---	86	76	8.6	.1	.0	550	375	5-	5-
46	" 6	T.*	Champaign	"	1	Car 3131	Chicago	5	0	0	44	1	1.9	---	20	12	0.	.05	.0	850	320	5+	3+ 2-
47	" 13	"	"	"	24	" 3106	Centralia	2	0	0	31	0	1.0	---	8	4	0.	.0	.0	20	14	5-	5-
48	" 13	"	"	"	24	" 3777	"	2	0	0	48	1	2.9	---	20	12	3.7	.0	.0	35	20	5-	5-
49	" 13	"	"	"	1	" 2514	Chicago	3	0	0	32	0	4.8	---	14	8	0.	.05	.1	1,350	900	4+ 1-	4+ 1-
50	" 13	"	"	"	1	" 3182	"	3	0	0	130	1	5.8	---	34	32	43.6	.0	.0	10	4	2+ 3-	2+ 3-
51	" 13	"	"	"	24	" 2504	Centralia	2	0	0	38	0	1.0	---	14	12	3.3	.0	.0	80	10	5-	5-
52	" 18	"	"	Big 4	16	" 655		2	0	0	85	19	0.0	---	50	32	0.	.2	.0	10,000	3,000	2+ 3-	2+ 3-
53	" 18	"	"	"	16	Coach 729	.	3	0	0	55	3	8.8	---	16	24	trace	.0	.1	27,000	3,000	5-	5-
54	" 18	"	"	"	16	Smoker 657	Peoria	10	0	0	330	30	21.6	---	170	244	55.1	.15	.2	500	800	5+	5+
55	" 18	"	"	"	16	Coach 717	"	10	0	0	260	20	15.4	---	136	176	45.3	.15	.0	----	1,200	5+	4+ 1-
56	" 24	"	"	I.C.	1	Car 3131	Chicago	2	0	0	60	2	6.7	---	38	28	trace	.0	.0	860	500	5-	5-
57	" 24	"	"	"	23	" 3102	"													90	25	5-	5-
58	" 24	"	"	"	1	" 2901	"	1	0	0	48	2	2.9	---	20	16	"	.0	.0	850	400	5-	5-
59	" 24	"	"	"	23	" 3162	"	1	0	0	118	2	7.7	---	62	28	21.2	.0	.0	75	25	5-	5-
60	" 28	"	"	"	1	Coach	"	2	0	0	110	12	6.7	---	36	48	79.4	.0	.0	1,200	350	5-	5-
61	" 28	"	"	"	23	Smoker	"	2	0	0	34	3	2.9	---	14	12	28.	.0	.0	30	3	5-	5-
62	" 28	"	"	"	1	Coach	"	2	0	0	570	42	22.1	---	139	260	256.	.1	.1	4,000	130	1+ 4-	1+ 4-
63	" 28	"	"	"	23		"	2	0	0	163	5	15.4	---	103	140	49.	.15	.0	20,000	210	1+ 4-	1+ 4-
64	June 1	"	"	Big 4	9	" 694	Indianapolis, Ind.	20	5	0	502	24	28.8	---	280	420	130.	.5	.3	600	350	1+ 4-	1+ 4-
65	" 1	"	"	"	9	" 655	Peoria	2	0	0	253	14	15.4	---	143	224	68.7	.25	.0	6,000	1,800	5-	5-
66	" 1	"	"	"	9	" 944	Indianapolis, Ind.	2	0	0	467	25	25.9	---	263	424	123.8	.4	.1	180	90	1+ 4-	1+ 4-
67	" 1	"	"	"	16	" 697	Peoria	2	0	0	202	23	15.4	---	95	128	40.3	.2	.0	160	20	5-	5-
68	" 10	"	"	"	16	" 655	"	0	0	0	286	38	11.5	---	130	120	42.8	.0	.0	12,000	8,000	5+	5+
69	" 10	"	"	"	9	" 944	Indianapolis, Ind.	0	20	0	441	21	4.8	---	248	220	88.4	.8	.0	20,000	11,000	5+	5+
70	" 10	"	"	"	16	" 697	Peoria	0	0	0	219	11	3.8	---	112	104	48.1	.1	.0	25,000	15,000	1+ 4-	1+ 4-
71	" 10	"	"	"	9	" 743	Indianapolis, Ind.	0	5	0	369	20	17.3	---	234	200	76.5	.1	..0	30,000	10,000	5+	5+
72	" 11	"	"	I.C.	622	" 1579	Havana, Ill.	0	3	0	25	3	5.8	---	10	44	6.2	1.4	.0	160	40	5-	5-
73	" 11	"	"	"	1	" 2507	Chicago	0	0	0	173	3	2.9	---	93	44	13.6	.1	.0	1,350	800	5+	4+ 4-
74	" 11	"	"	"	1	" 2514	"	0	0	0	127	2	2.9	---	94	36	8.2	.0	..0	1,800	1,000	5+	5+
75	" 19	B.*	"	C.B.&Q.	2	"	Lincoln, Ill.	2	0	0	293	18	11.5	---	162	112	57.2	.4	.0	7,000	2,250	2+ 3-	2+ 3-
76	" 19	"	"	"	58	Sleeper	Minneapolis, Minn.	2	0	0	146	3	6.7	---	45	36	30.9	.6	.0	30	3,600	5-	5-
77	" 19	"	"	Penn.	15	Coach	Ft. Wayne, Ind.	0	0	0	162	16	2.9	---	26	56	65.0	.6	.0	15	1,350	5+	5+
78	" 19	"	"	C.&A.	10	Smoker	Kansas City, Mo.	30	15	3m	268	12	4.8	---	88	104	83.9	.0	.0	80,000	30,000	5+	5+
79	" 19	"	"	C.M.&St.P	2	Coach	Mason City, Ia.	0	0	0	170	17	10.6	---	66	92	40.3	.0	.0	5,500	1,500	2+ 3-	2+ 3-

*Collections have been made by F. W. Mohlman (M), F. W. Tanner (T), and A. N. Bennett (B).

Sample No.	Date of Collection 1914		Collector	City	Railroad	Train No.	Car	Tank filled at	Turbidity	Color	Odor	Residue	Chlorine	Magnesium	Alkalinity M. O.	Hardness $CaCO_3$	Sulfate	Iron	Copper and Lead	Bacterial Count Gelatin	Bacterial Count Agar	B. coli Gas formation 10 cc. L.B.	B. coli Gas formation 10 cc. Conf.
80	June	18	B.*	Chicago	C.&A.	8	Coach	St. Louis	0	0	0	169	2	12.5	116	116	none	.0	.0	10,000	180	5+	1+ 4-
81	"	19	"	"	Penn.	25	Sleeper	Pittsburg	0	0	0	145	4	12.5	116	96	"	.0	.0	220	35	2+ 3-	5-
82	"	19	"	"	C.B.&Q.	56	"	Kansas City, Mo.	0	0	0	185	7	12.5	64	76	69.1	.0	.0	340	450	2+ 3-	2+ 3-
83	"	19	"	"	C.M.&St.P.	12	"	"	5	0	0	142	6	5.8	50	48	42.8	.0	.0	900	2,250	2+ 3-	2+ 3-
84	"	19	"	"	Penn.		Parlor car	Chicago	10	0	0	158	5	9.6	114	76	20.6	.0	.0	10,000	5,400	2+ 3-	2+ 3-
85	"	25	C.*	"	M.C.	17	Sleeper	Detroit	2	0	0	128	4	10.6	64	48	trace	.0	.0	1,350	230	5-	5-
86	"	25	"	"	"	17	"	"	2	0	0	23	10	6.7	18	8	"	.0	.0	2,900	1,260	5-	5-
87	"	25	"	"	"	17	Parlor car	"	2	0	0	58	3	10.6	36	32	"	.0	.0	5,000	510	2+ 3-	5-
88	"	25	"	"	"	13	Coach	"	2	0	0	166	25	18.2	96	48	"	.0	.0	9,000	520	5-	5-
89	"	25	"	"	"	13	Sleeper	New York	2	0	0	48	3	5.8	22	8	"	.0	.0	1,560	640	2+ 3-	1+ 4-
90	"	25	"	"	"	13	"	"	3	20	0	120	5	15.4	58	72	"	.0	.0	220	91	2+ 3-	5-
91	"	25	"	"	I.C.	24	Parlor car	Mattoon	5	15	0	302	12	33.6	252	144	"	trace	.0	8,100	6,600	1+ 4-	1+ 4-
92	"	25	"	"	"	24	Coach		1	0	0	44	2	8.6	16	4	"	.0	.0	260	183	5-	5-
93	Dec.	30	H.*	Champaign	"	23	Smoker	Chicago	2	3	0	24	6	4.8	21	16	.0	.1	.0	10,000	17	5-	5-
94	"	30	"	"	"	24	Coach 2166	Centralia	2	0	0	124	5	12.5	95	76	.0	.1	.0	25	2	5-	5-
95	"	30	T.*	"	"	1	" 3107	Chicago	2	0	0	426	35	19.2	124	192	16.7	.2	.0	13	33	5-	5-
96	"	30	H.*	"	"	24	" 2127	Centralia	2	2	0	28	6	.0	21	0	.0	.3	.0	14	4	5-	5-
97	"	30	T.*	"	"	1	" 2507	Chicago	0	0	0	81	8	6.7	35	32	trace	.5	.0	3,000	120	1+ 4-	5-
98	"	30	"	"	"	1	" 2515	"	0	2	0	132	16	10.5	42	54	4.8	.1	.0	1,200	14	5-	5-
99	"	30	H.*	"	"	1	Diner	Hammond, La.+	0	2	0	179	7	21.1	100	undet.	.0	.3	.0	250	110	5+	5+
100	"	31	T.*	"	"	1	Coach 2117	Chicago	3	0	0	60	5	4.8	32	"	.0	.0	.0	5	6	5-	5-
101	"	31	H.*	"	"	1	Parlor car	"	25	0	0	175	6	6.7	114	80	.0	1.6	.0	1	10	5-	5-
102	June	25	C.*	Chicago	"	25	Coach	"	1	0	0	27	3	.0	6	0	trace	.0	.0	580	260	1+ 4-	5-

*Collections were made by F. W. Mohlman (M), F. W. Tanner (T), A. N. Bennett (B), H. P. Corson (C), and W. W. Hanford (H)

+Denotes bottled water.

by both the standard for B. coli and agar count of the Commission. Four more did not conform to the B. coli standard alone and 24 more did not conform to the agar count standard, making a total of 49 of 67 samples or 73% which did not conform to the standards set by the Commission.

One hundred and nine positive tests for gas formation were obtained, 91 or 83% of these were confirmed as B. coli.

INVESTIGATION OF SOURCES

In order to save time and expense in traveling, circular letters were written to every railroad operating in Illinois, calling their attention to the Treasury regulations and asking them to submit a list of localities from which water was taken for drinking purposes on its particular trains. The railroads were very appreciative of the work and promptly responded. Of the replies received from 64 railroads, 99 sources of water for railroads were found.

Below will be found a table of the analyses completed thus far in the investigation. The Standard Method of the A.P.H.A. has been followed in the chemical work, the Treasury Standard being followed in the bacteriological examination.

From Table No. VII. Chemical Data of 99 Sources.

Ninety-nine sources were examined for turbidity; 49 showed a turbidity of less than 5 parts per million; 62, less than 10; 74, less than 15; and only 25 showed a turbidity of 15 or more. A turbidity of 10 or less would seem a reasonable standard.

Ninety-nine were examined for color. Fifty-three of the sources had a color less than 5 parts per million; 71, less than 10; 86, less than 20; and only 13 had a color of 20 or more. A color of 20 or less would appear to be easy to obtain and would not be noticeable in a glass of water.

In no case was there odor of chlorine or hydrogen sulfide noticeable when the bottle was shaken without heating. It would not be unreasonable to require that odor of chlorine and hydrogen sulfide be absent.

Ninety-nine sources were examined for residue. Of these, 10 had a residue less than 250 parts per million; 50, less than 500; 79, less than 1000; and 21 above 1000. A standard of 1000 parts per million for residue would seem reasonable. Owing to the physiological action of some salts, and to the sensitiveness of many people to waters containing salts, it might be advisable to require a residue of less than 500 unless the normal for the line is shown to be greater.

Chlorine was determined in 99 sources. Of these, 61 had less than 25 parts per million; 74, less than 50; 84, less than 100; 92, less than 200; 93, less than 250; and only 6 more than 250. It would seem reasonable to set a limit of 50 or 25 parts per million for chlorine, unless it is necessary to use waters of high mineral content of acknowledged hygienic purity.

The alkalinity, using phenolphthalein and methyl orange as indicators, was determined in 99 sources. In but one case was a water found which was alkaline to phenolphthalein. A requirement that the alkalinity to phenolphthalein shall not be greater than one-half the alkalinity to methyl orange would guard against the use of water overtreated with lime. From the results thus far obtained this requirement would work no hardship upon the railroads. Eight sources contained less than 100 parts of alkalinity to methyl orange; 21, less than 200; 56, less than 300; 91, less than 400; and 8, more than 400. The residue may consist entirely of carbonates. If a standard of 500 is fixed for residue the same standard may be fixed for alkalinity.

Bacteriological Data of 94 Sources.

Twenty-seven have an agar count greater than 100 per cc., and, therefore, did not conform to the Treasury Department Standard; 32 did not conform to the B. coli standard proposed by the same Department; 15 did not conform to both standards; thus in all, 44 or 47% of the sources did not meet the Treasury Standards.

Examination of Ice.

Sixteen samples of ice were examined. In but one case was there any difficulty in meeting the Treasury Standards. In this single instance the cake was not representative of the whole harvest, as it contained flakes of dirt which might very well envelop B. coli. Another sample was taken and very satisfactory results obtained.

TABLE VIII.

Town	Turbidity. Raw	Turbidity. Treat.	Color Raw	Color Treat.	Odor Raw	Odor Treat.	Residue Raw	Residue Treat.	Chlorine Raw	Chlorine Treat.	O.Consumed Raw	O.Consumed Treat.	Free NH_3 Raw	Free NH_3 Treat.	Alb. NH_3 Raw	Alb. NH_3 Treat.	Nitrites Raw	Nitrites Treat.	Nitrates Raw	Nitrates Treat.	Alkalinity Raw	Alkalinity Treat.
E. St.Louis	70	0	30	25	0	0	295	203	5.6	6.6	7.7	5.2	.128	.056	.360	.198	.015	.000	1.12	1.12	130	130
Hamilton	35	0	30	0	1v	0	189	172	2.8	2.8	7.2	3.5	.104	.108	.360	.148	.010	.003	1.00	1.00	122	112
Granite City	65	10	20	10	1e	1e	300	226	6.2	6.6	7.0	3.5	.120	.108	.320	.186	.024	.001	1.28	1.20	132	126
Warsaw	45	3	20	0	1v	1e	202	170	4.	5.	7.5	4.4	.174	.186	.436	.204	.017	.006	.88	.88	122	108
Alton	35	0	40	10	0	1v	285	259	10.2	9.8	6.0	2.5	.080	.082	.400	.206	.011	.038	1.52	1.28	150	150
Quincy	35	0	35	0	1e	1m	203	189	4.0	3.8	7.6	3.2	.200	.096	.520	.142	.015	.000	.72	.80	124	104
Rock Island	65	0	40	0	1e	0	342	138	1.8	4.0	9.4	4.0	.128	.056	.440	.146	.008	.000	.24	.32	72	52
Cairo	60	25	15	0	1e	1e	210	166	10.	14.	2.0	1.0	.040	.032	.208	.078	.002	.000	.76	.80	74	46
Mt. Carmel	35	0	10	0	2a	0	421	390	36.	35.	4.5	2.5	.052	.012	.296	.102	.006	.000	.88	1.00	202	186
Danville	15	2	30	15	1e	1e	323	309	5.	6.	4.2	2.4	.058	.052	.204	.148	.010	.013	.80	.68	210	202
Pontiac	25	0	25	5	2v	1v	421	395	6.	10.	4.6	2.6	.064	.072	.296	.184	.025	.004	1.48	1.72	218	210
Streator	25	0	20	10	1v	0	371	363	16.	16.	5.2	3.2	.094	.082	.290	.184	.004	.000	.60	.72	178	164
Kankakee	25	0	30	25	1e	0	421	376	2.	4.	5.8	4.5	.064	.040	.246	.202	.000	.002	.88	.80	186	186
Decatur	15	0	10	0	1e	1v	320	315	9.	9.	3.8	2.4	.064	.052	.240	.158	.022	.000	.72	.92	238	232
Macomb	40	0	20	5	1v	0	288	229	8.	8.	5.0	3.0	.102	.054	.370	.180	.002	.000	.08	.08	186	164
Anna	35	5	10	0	1a	0	212	160	5.	5.	3.2	1.4	.042	.064	.240	.106	.022	.001	.56	.76	150	114
Carlinville	30	10	10	10	1m	0	317	316	5.	5.	7.4	3.2	.132	.052	.574	.266	.064	.021	.60	.64	68	60
Mt. Vernon	5	0	15	5	1v	1v	374	340	11.	11.	3.3	1.8	.120	.028	.286	.134	.001	.001	.60	.72	60	52
Centralia		45		20	[illegible]	2a	[illegible]	149	[illegible]	5.		3.8		.028		.234		.000		1.00		30
Breese	20	15	0	0	1e	0	424	411	15.	14.	3.5	3.5	.150	.094	.288	.270	.000	.020	.28	.20	2228	228
Ft. Sheridan	10	0	10	0	1v	0	159	143	5.	5.	1.6	1.2	.026	.050	.112	.124	.000	.000	.24	.24	116	112
Waukegan	5	5	5	0	1m	2a	147	150	5.	5.	2.2	1.7	.038	.046	.108	.110	.000	.000	.32	.24	114	114
Great Lakes	3	0	0	0	0	0	143	148	5.	5.	1.7	1.6	.048	.048	.150	.098	.000	.000	.24	.32	114	114
Kennilworth	5	0	0	0	1a	0	155	139	5.	5.	1.1	.8	.034	.050	.096	.076	.000	.000	.28	.56	108	100
Lake Forest	5	0	0	0	1a	0	149	149	5.	5.	2.4	2.0	.046	.078	.112	.114	.000	.000	.44	.44	112	114
Winnetka	10	0	0	0	1e	0	145	140	5.	5.	2.1	1.6	.052	.050	.120	.102	.000	.000	.24	.60	114	114
Evanston	7	0	5	0	1a	0	130	142	4.	4.	2.0	.8	.124	.032	.052	.108	.000	.000	.28	.36	114	108

TABLE VIII. (continued)

Town	Source	Count on Agar Raw	Agar Treated	Gelatin Raw	Gelatin Treated	Gas Formation in Lactose Broth Raw 10cc.	Raw 1cc.	Raw .1cc.	Treated 10cc.	Treated 1cc.	Treated .1cc.	Negative	Positive	Endo's	Confirmed	Not confirmed	Indol Raw	Indol Treated	Type of treatment
E. St.Louis	Miss. R.	1,260	18	5,000	50	1+	2+	1+1-	1+	2-	2-	2	3	0	0	2	+	+	M.A.H.
Hamilton	"	112	1	930	5	1+	2+	2-	1-	2-	2-	0	5	0	0	0	-	-	M.A.
Granite City	"	175	4	400	90	1+	2+	2+	1-	2-	2-	2	3	0	0	2	+	-	A.H.
Warsaw	"	87	14	360	187	1+	2+	2-	1+	2-	2-	4	1	4	4	0	-	-	M.A.H.
Alton	"	153	8	370	36	1+	2+	2-	0	2-	2-	0	5	0	0	0	+	+	"
Quincy	"	700	0	3,000	4	1+	2+	2+	1-	2-	2-	0	5	0	0	0	+	-	"
Rock Island	"	296	11	560	37	1+	2+	1+1-	1-	2-	2-	0	5	0	0	0	+	+	"
Cairo	Ohio R.	195	6	260	19	1+	1+1-	2-	1+	1+1-	2-	1	4	0	0	1	+	-	"
Mt. Carmel	Wabash R.	140	con.	800	75	1+	2-	1+1-	1-	2-	2-	0	5	0	0	0	+	+	"
Danville	Vermilion R.	390	10	45	70	1-	2-	2-	1-	2-	2-	0	5	0	0	0	+	+	"
Pontiac	"	300	8	600	9	1+	2+	1+1-		2-	2-	1	3	1	1	0	+	-	"
Streator	"	200	3	1,600	19	1+	2+	1+1-	1-	2-	2-	0	5	0	0	0			"
Kankakee	Kankakee R.	230	18	5,000	450	1+	2+	1+1-	1+	2-	2-	4	1	3	3	1	+	+	"
Decatur	Sangamon R.	750	25	300	5	1+	2-	2-	1-	2-	2-	0	5	0	0	0	+	-	"
Macomb	Creek	870	7	1,200	120	1+	2+	2-	1-	2-	2-	1	4	1	1	0	+	-	"
Anna	"	63	9	240	13	1+	2+	2-	1+	2-	2-	1	4	1	1	0	+	-	"
Carlinville	"	17	44	130	53	1-	2-	2-	1+	2-	2-	2	3	1	1	1	-	-	M.A.
Mt. Vernon	"	38	21	65	93	1-	2-	2-	1-	2-	2-	0	5	0	0	0	-	-	M.A.H.
Centralia	"	300	155	50	102	1+	2-	2-	1+	2-	2-						+	+	Hypo alone
Breese	"	950	290	1,300	460	1+	2+	1+2-	1+	2+	2-	5	0	5	5	0	+	+	S.
Ft.Sheridan	Lake Mich.	68	0	90	0	1-	2-	2-	1-	2-	2-	0	5	0	0	0	+	-	M.A.H.
Waukegan	"	40	0	170	0	1+	2-	2-	1-	2-	2-	0	5	0	0	0	-	-	Hypo alone
Great Lakes	"	3	0	6	4	1-	2-	2-		2-	2-	0	5	0	0	0	-	-	S.S.F.
Kenilworth	"	3	5	19	7	1+	1+1-	2-		2-	2-	0	5	0	0	0			M.A.
Lake Forest	"	9	0	8	30	1-	1+1-	2-	1+	2-	2-	5	0	5	5	0			M.A.H.
Winnetka	"	10	0	68	3	1-	2-	2-		2-	2-	0	5	0	0	0			Hypo alone
Evanston	"	19	3	130	12	1+	2+	1+1-	1-	2-	2-	0	5	0	0	0	+	-	M.A.H.

Note--M.A.H. = Mechanical Filter Alum; Hypochlorite; A.H. = Alum and Hypochlorite; M.A. = Mechanical Filter Alum; S. = Sedimentation; S.S.F. = Slow Sand Filter.

Examination of Municipal Filter Plant Effluents.

In order to have authentic samples, with the assistance of Mr. W. F. Langelier during the month of April, 1915, 26 of the purification plants of Illinois were visited. Samples of the raw and treated water were collected in each case and shipped, packed in ice, to the laboratory, where the analysis was started immediately.

Below will be found a table showing the condition of the raw water and the result after treatment in the light of the Treasury Standards. (See Table VIII.)

It is to be noted that but 3 of the filter plants are producing an effluent which would be condemned by the Treasury Standards. The other two towns which do not meet the standards, are not typical municipal plants. Breese uses coagulation and sedimentation. However, at the time of inspection Breese was using no coagulant. Centralia uses hypochlorite alone. Concerning the three filter plants which do not meet the standards, Warsaw is using one of the small wooden tub filters where the rate controller is changed considerably during the day to meet the demand. Lake Forest has a new filter, but is not an approved type, and it is doubtful that good results will be obtained consistently. Kankakee has a plant from which fluctuations of quality are to be expected. The apparatus used does not permit a uniform application of hypo.

However, one in looking at the analyses of the raw waters of these plants is impressed by the fact that in many places very little purification was needed. The inspection trip was taken in April before which time there had been little or no rain, thus it was not surprising that in general the plants of the state during times when the B. coli content of the raw water is not high, could produce an effluent which would conform to the standards. It was expected that another similar trip would be taken after a heavy rain that the extremes might be contrasted, but due to the continued drought such a trip was not possible. However, from data of analyses previously made by this laboratory and at the newer installed filtration plants where bacteriological control is maintained we would expect very few, if any, of the plants to have an effluent continuously thruout the year which would meet the standards recommended by the Treasury Department.

Of a total of 184+ fermentations in lactose broth in Table VII, 166 or 90.2% developed red colonies on Endo's medium. Of these 166 acid producers when transplanted into lactose broth, 132 produced + fermentations.

It is to be expected that B. coli will be missed occasionally due to their slight motility. They become entangled in the sludge which separates out from the medium and presumably are in the bottom of the fermentation tube, thus great care to shake violently must be taken before transplanting into Endo's medium. Also, the fact that not all B. coli colonies are red, but remain white must be taken into consideration. Those which are luscious and look like B. coli, have been found to produce gas when reinoculated into lactose broth.

Based upon the analyses in the tables above and what is known concerning the physiological effect of the various constituents of water, the following chemical and bacteriological standards seem reasonable:

Chemical Standards.

1. Turbidity not greater than 10.

2. Color " " " 20.

3. There shall be no odor of hydrogen sulfide or free chlorine.

4. Residue not greater than 1000, preferably 500.

5. Sulfates " " " 250.

6. Chlorine as chlorides not greater than 50.

7. Lead or copper not greater than .3.

8. The phenolphthalein alkalinity shall not be greater than 1/2 the methyl orange.

Bacteriological Standards.

1. Count on agar at 37-1/2° when incubated 24 hours shall not exceed 75 per cc. in a sample taken from the source of supply.

2. Not more than 2 out of 5 10cc. portions when planted in fermentation tubes containing from 30 to 40 cc. of lactose, peptone broth, shall show more than 5% gas in the closed arm.

The chemical analysis shall be carried on as recommended in the "Standard Methods of Water Analysis" of the American Public Health Association, 1912, except in the determination of lead or copper and sulfates. The sulfates shall be determined by the ordinary gravimetric method by precipitation with $BaCl_2$ or the Benzidene Volumetric method.*

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*Freidham and Nydegger - Z. angew. Chem. 1907, 9.

Lead and copper shall be determined as follows, except in case a relatively large amount (i.e. over .3 p.p.m.) being found when Standard Methods are to be followed. To 100 cc. of water add 2 g. pure crystals of ammonium chloride, 2 cc. of acetic acid and 2 to 3 drops of 10% sodium sulfide (Na_2S) solution. Compare immediately with standards containing known amounts of lead nitrate ($PbNO_3$). The standards should contain .01, .02, .03 mg. of Pb.

Media shall be made as recommended in Standards Methods of A. P. H. A., except that this laboratory has found that Endo's medium prepared according to the following formula which is a modification of the one proposed by Hiss and Zinsser in their textbood of bacteriology:

1. Prepared one liter of solution, 3% of agar, containing 10 g. of peptone, 5 g. NaCl, and 3 g. Liebig's meat extract.

2. Neutralize and clear by filtration.

3. Add 10 cc. of a 10% solution of sodium hydrate solution in order to render alkaline.

4. Add 10 g. of C.P. lactose.

5. Add 5 cc. of saturated alcoholic solution of fuchsin, filtered before using. This colors the medium red.

6. Add Twenty-five cubic centimeters of 10% sodium sulfate solution (kept in dark place). This again decolorizes the medium, the color not entirely disappearing, however, until the agar is cooled. Put into test tubes, 10cc. each and sterilize and keep in the dark. The colonies of B. coli are pink upon this medium.

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